II.—FOSSILS FROM THE WOORAMEL DISTRICT, WESTERN AUSTRALIA.*

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I.—INTRODUCTION.

The fossils described in the following pages were collected by Messrs. H. W. B. Talbot and F. R. Feldtmann in March, 1929, while engaged in geological reconnaissance in the Wooramel District. At the request of Mr. T. Blatchford, Government Geologist, I undertook the identification of the fossils. As these include several forms new to Western Australia as well as several apparently new species, three of which mark a definite horizon hitherto unrecognised in the Western Australian Permo-Carboniferous, the material seems of sufficient interest to be published.

Where the collection contained only one specimen of a new species, I have supplemented the notes on the species by referring to additional specimens from a collection made by Mr. R. A. Hobson.

I am indebted to Mr. Blatchford for the opportunity of examining the fossils in the collection of the Geological Survey, and to Colonel Nicholson of the Wooramel Oil Syndicate for making available extra material from Mr. R. A. Hobson's collection. I have also to thank Professor E. de C. Clarke for his constant advice and help. The photographs were taken by Mr. H. G. Smith, of the Department of Geology in the University of Western Australia, whose efforts were untiring in obtaining the best possible results from difficult subjects.

* Part of the cost of publication of this paper has been borne by the Department of Geology in the University of Western Australia.

II.—LOCALITY, AGE AND FOSSILIFEROUS HORIZONS.

The fossils were collected within a fifteen mile radius from Callytharra Springs (lat. 25° 52′ S., long. 115° 30′ E.) on the Wooramel River. Details of the localities are not given in the text but are tabulated below.

Locality Numbers	1	1a	2	3	4	5*	6	7	8	8a
	Two miles E.S.E. of Survey Station R20.	On Wooramel River, two miles almost East of Survey Station R20.	Bed and Bank of Wooramel River, three miles above R20.	Creek ½-mile West of Callytharra Springs.	S. bank of Wooramel, ¼-mile above Callytharra Springs.	1 mile from S. bank of Wooramel, 1 mile above Callytharra Springs.	South bank of Wooramel, below Callytharra Springs.	South bank of Wooramel, 1 mile above Callytharra Springs.	Bogadi Outcamp, 7 miles South of Survey Station R18.	Ferruginous ridge near telephone line, ½-mile from Bogadi Outcamp.
COELENTERATA—										
ACTINOZOA :										
Clisiophyllum talboti, n. sp.	...	...	...	×	...	...	...	...	...	...
Plerophyllum australe, Hinde.	...	...	...	×	...	...	×	...	...	...
ECHINODERMATA—										
CRINOIDEA :										
Crinoid stems	...	...	...	×	×	×	×	...	...	...
,, plate.	...	...	...	×	...	...	...	...	...	...
ECHINOIDEA :										
Echinoid plate.	...	...	...	...	...	×	...	...	...	...
POLYZOA—										
Aetomacladia ambrosoides, Bretnall	...	...	...	×	...	×	×	...	...	...
?Coscinum	...	...	...	×	...	...	...	...	...	...
Fenestella affluensa, Bret.	...	...	...	...	...	...	×	...	...	...
,, *fossula*, Lonsd.	...	...	...	...	×	×	×	...	...	...
,, *horlogia*, Bret.	...	...	...	×	...	×	×	...	...	...
Rhombopora mammillata, Bret.	...	...	...	...	...	...	×	...	...	...
,, *multigranulata*, Bret.	...	...	...	...	...	×	×	...	...	...
Streblotrypa marmionensis, Eth. jun.	...	...	...	...	...	×	×	...	...	...
Sulcoretepora meridianus, Eth. jun.	...	...	...	×	...	...	×	...	...	...
BRACHIOPODA—										
Aulosteges ingens, n. sp.	...	×	×	...	...	...	...	...	...	...
Aulosteges spinosus, n. sp.	...	...	...	...	...	...	×	.		...
Chonetes pratti, Dav.	...	...	...	×	×	...	×	...	...	...
Cleiothryis macleayana, Eth. jun.	...	...	...	×	×	×	×	...	...	...
Dielasma, sp.	...	...	...	×	...	...	...	...	...	...
Dielasma cymbaeformis, Morris	×	...	...	...	...	...	...	...	...	...
Productus undatus, Defrance	...	...	...	...	×	×	...	×	...	...
,, *semireticulatus*, Martin	...	...	...	×	×	...	...	×	...	...
,, *subquadratus*, Morris	...	...	...	×	...	...	...	...	...	...
,, *tenuistriatus* var. *foordi*, Eth. jun.	...	...	...	×	×	...	×	×	...	...
Reticularia lineata, Martin	...	...	...	×	×	...	...	...	...	...
?Spirifer byroensis, Glauert	...	...	...	...	...	...	...	...	×	
Spirifer hardmani, Foord	...	...	...	×	...	...	...	...	...	...
,, *musakheylensis* var. *australis*, Foord	...	...	...	×	...	...	×	...	...	...
Spirifer rostalinus, n. sp.	×	×	×	...	...	...	...	...	×	...
Spiriferella australasica, Eth. jun.	...	...	...	×	×	...	×	×	...	...
Strophalosia, sp.	...	...	...	...	×	...	...	...	...	...
MOLLUSCA—										
LAMELLIBRANCHIATA :										
Cardiomorpha blatchfordi, n. sp.	×	×	×	...	...	...	...	...	×	×
Cardiomorpha, n. sp. ?	...	...	...	...	...	...	×	...	...	...
Deltopecten subquinquelineatus, McCoy, var. *comptus*, Dana	×	×	×	...	...	×	...	...	×	×
Parallelodon, sp.	...	...	...	...	...	...	×	...	...	...
GASTROPODA :										
Ptychomphalina maitlandi, Eth. jun.	×	×	×	...	...	...	...	...	?	...
PTEROPODA :										
Conularia cf. *C* warthi, Waagen.	×	...	...	...	...	...	...	...	×	...

* According to Mr. Talbot these specimens were wrongly labelled, as no fossils were collected at this spot.

From this table it is seen that there is a strong resemblance between the faunas of localities 1, 1a, 2, 8 and 8a. These are characterised by the presence of abundant specimens of *Deltopecten subquinquelineatus* McCoy var. *comptus* Dana* and *Spirifer rostalinus* Hosking. At localities 1, 1a and 2 the enclosing rock is a buff-coloured sandy shale of fine sandstone, whereas at 8 and 8a the fossils are limonitic casts and replacements, apparently derived from a ferruginous sandstone, probably a local variation of the rocks found at localities 1, 1a and 2.

Localities 3, 4 and 7 show the same association of fossils as found in the Fossil Cliff beds† on the Irwin River (lat. 28° 25′, long 115° 15′).

The beds at locality 6, although they carry numbers of fossils common in the Irwin River beds, contain great numbers of bryozoa, which, excepting *Fenestella*, have not been recorded from the Irwin River beds, but which are identical with those described by R. W. Bretnall (G.S.W.A., Bull. 88) from the Gascoyne River District, Mt. Marmion and Wyndham River.

There are, therefore, two, or perhaps three fossiliferous horizons in the area :—

(a) The Deltopecten Horizon represented by columns 1, 2 and 8.

(b) The " Irwin " Horizon represented by columns 3, 4 and 7—correlated with the Fossil Cliff beds, Irwin River

and possibly

(c) Represented by column 6 characterised by the abundance of bryozoa.

From field evidence supplied by Mr. Hobson, the beds at locality 2 are above those of locality 3, so that the Deltopecten horizon is higher than the Irwin horizon. Mr. Talbot considers it likely that the bryozoan rock from locality 6 does represent a horizon distinct from that of the " Irwin horizon " of the Wooramel and if so is possibly above it.

The age of the beds further than that they are Carboniferous or Permo-Carboniferous, cannot be determined simply by correlation of the fossils with related species from other parts of the world. *Deltopecten comptus* which I have united with *Deltopecten subquinquelineatus*, is found in the Upper Marine of New South Wales ; *Spirifer nitiensis* allied to *S. rostalinus*. var *auritus* is found in the Permian of the Salt Range and Spiti ; *Conularia warthi* is found in the Permian of thé Salt Range. On Schuchert's classification (Bull. Geol. Soc. America, Vol. 39, p. 798, 1928) the Deltopecten beds, which contain these three species, then fall within the Upper Permian. *Clisiophyllum talboti* from the Irwin horizon closely resembles *C. turbinatum* from the Mountain Limestone of England. The Irwin horizon, however, is usually correlated with the Greta series which Schuchert places as high as Middle Permian. In the face of conflicting evidence such as this, the study of distribution of species can be of little use until the stratigraphical relationship of the various members of the Carboniferous or Permo-Carboniferous rocks of the State has been determined in the field.

* A single specimen of Deltopecten is recorded from Locality 5 but is apparently wrongly labelled, *see* footnote to locality table.

† Woolnough, W. G. and Somerville, J. S.—Roy Soc. N.S.W., Vol. LVIII, 1924, p. 91.
Campbell, W.D.—G.S.W.A. Bulletin 38, 1910, p. 49.

III.—DESCRIPTION OF THE FOSSILS.

PHYLUM COELENTERATA.

CLASS ACTINOZOA.

Genus CLISIOPHYLLUM Dana.

(Edwards & Haime, Brit. Foss. Corals, p. lxx., Palaeont. Soc. 1850–54).

Clisiophyllum talboti, n. sp.

Plate III., figs. 1–3.

Description : Corallum simple, conical to turbinate, some individuals shorter and stouter than others ; one specimen enlarges rapidly to a diameter of 30 mm. at about 35 mm. from the base. The calyx is circular to oval ; the average diameter of a circular specimen is 22 mm. ; one oval specimen has a longer diameter of 30 mm. and a shorter diameter of about 24 mm. The calyx is fairly deep with a thin edge. The epitheca is thick. The corallum is externally marked by longitudinal rounded ridges which in some places are not straight but slightly waved. These are crossed by irregular crumples and fine growth striae. The septa rise in the centre to form a false columella. About twenty septa stand out as ridges on the weathered surface of this central axis. Two of these, diametrically opposite, are stronger than the others and form a median crest. The central axis is about one-third of the diameter of the corallum. There are between 28 and 32 strong septa. Alternating with these are a series of rudimentary septa which are unequally developed on opposite sides of the calyx. None of the specimens have the margins of the calyx preserved entire. Several show the secondary septa on the higher part of the calyx preserved on one side but these are absent on the side broken off lower down. Probably were the entire margin present the secondary septa would be seen all round the calyx. They must have developed at a lower level on one side, however, as ground and natural sections towards the base of the calyx show their presence on one side and absence on the other.

Remarks : The specimens resemble *C. turbinatum* McCoy (*) in shape, size of the axial boss and prominence of axial boss and crest. The generic description of *Clisiophyllum* gives "septa rising towards the centre of the calice so as to form a spurious columella, but not twisted." In *C. turbinatum* the septa "bend slightly on the sides of a well developed lamellar columella." In the present specimens the septa viewed from the top of the calyx appear straight or only slightly bent at the columella. One specimen, however, from which the sides have been broken far down the cup exposing the columella, shows that the septa twist slightly round the columella as they ascend—thus showing some affinity with the genus *Ptychophyllum.*

Descriptions of *C. turbinatum* do not mention ornamentation of longitudinal ribbing, but this is shown by a figure of *C. turbinatum* from the Mountain Limestone (Edwards & Haime, Fig. 1, pl. XXXIII).

(*) *Turbinolia fungites* (pars ?, Fleming, Brit. Anim., p. 510, 1828.
Cyathophyllum fungites, de Kon. An. Foss. Terr. Carb. de Belg., p. 24, pl. D, fig. 2, 1842.
Clisiophyllum turbinatum, McCoy, Ann. Nat. Hist. Ser. 2, Vol. VII, p. 169, 1851.
Clisiophyllum Koninckı, Milne Edwards and Jules Haime, Pal. Foss. des Terr. Palaeoz., p. 410, 1851.
,, *turbinatum*, McCoy, Brit. Pal. Foss. p. 88, and 96 figs. a, b, c, 1851.
Milne Edwards and Jules Haime, Mon. Brit. Corals, Pt. III., Corals Perm. Formn. and Mountain Limestone, p. 184., pl. 33, figs. 1, 1a, 2. Pal. Soc. 1852.

Although in general appearance these specimens are like *C. turbinatum*, they may be distinguished as a new species by the constant difference in the number and arrangement of the septa. Five specimens show between 28 and 32 septa as opposed to 44–54 of *C. turbinatum*. In four of these (the fifth is too poorly preserved) the rudimentary septa are visible on one side of the cup, but are scarcely discernible on the other.

I have named the species after Mr. H. W. B. Talbot who has contributed so much to the knowledge of the geology of this State.

Specimen Numbers : Geological Survey $\frac{1}{4660}$ & $\frac{1}{4962}$.

Genus PLEROPHYLLUM* Hinde.

(Geological Magazine (3) VII., p. 195, 1890).

Plerophyllum australe, Hinde.

Plate III., figs. 4–6.

1890—*Plerophyllum australe*, Hinde, Geol. Mag. (3) VII., p. 196, pl. VIIIA, fig. 1a–1f.

1903—*Pleurophyllum australe*, Etheridge, jun., Geol. Survey, W.A. Bull. 10, p. 8.

1907—*Pleurophyllum australe*, Etheridge, jun., Geol. Survey, W.A., Bull. 27, p. 27, pl. VII., fig. 1; Pl. VIII, fig. 10.

1914—*Pleurophyllum australe*, Etheridge, jun., Geol Survey, W.A., Bull. 58, p. 13.

The specimens from the Wooramel differ in external features from *Plerophyllum australe* as originally described by Hinde. They show fine regular longitudinal ribs with some irregular transverse crumples, but on the upper part of the calyx of three specimens the longitudinal ribs disappear and only fine transverse wrinkles are to be seen as shown in Hinde's figure 1b

Some years ago while examining numbers of small conical corals from Fossil Cliff, Irwin River, I noticed that among those having the typical structure of *P. australe* in cross section, were not only weathered examples with longitudinal furrows representing the median laminae of the septa (Hinde, fig. 1a) and pieces with concentric lines (Hinde, fig. 1b), but numbers of unweathered specimens showing external ribbing and a few showing the lower part of the calyx ribbed and the upper part concentrically striated. There is no doubt that these must be included in Hinde's species and, therefore, his description of the ornamentation of the species should be altered to read thus : " the exterior surface of this species when well preserved shows fine longitudinal ribs, which may disappear on the upper part of the calyx and their place be taken by fine concentric striae ; when weathered the median laminae of the septa are shown as deeply impressed longitudinal lines or furrows."

Specimen Numbers : Geological Survey $\frac{1}{4700}$. Department of Geology University—8491 & 8501.

* I can find no authority for the use of *Pleurophyllum* instead of the author's *Plerophyllum*, from πλήρης, full, in allusion to the way in which the corallum is filled up by stereoplasm.

PHYLUM POLYZOA.

Genus AETOMACLADIA Bretnall.

(G.S.W.A. Bull. 88, 1926, p. 21).

Aetomacladia ambrosoides Bretnall.

Plate IV., fig. 4.

Aetomacladia ambrosoides, Bretnall, G.S.W.A., Bull 88, p. 21, pl.I., fig. 4.

Branches about 1–1½ mm. in diameter giving off secondary branches at right angles. The obverse is strongly keeled ; each side of the keel is highly inclined, and bears diagonal rows of zoecia, usually three in an oblique row. Longitudinally the zoecia are in sub-alternating rows. Interzoecial surfaces smooth. Reverse surface smooth and rounded.

The only difference from the description of the type shown by my specimens is that the secondary branches are irregularly developed. Bretnall states "the offshoots are 5 mm. apart." I have some pieces 12 mm. in length with no sign of branches, and others on which secondary branches are only 3 mm. apart.

Specimen numbers : Geological Survey $\frac{1}{4688}$D, $\frac{1}{4679}$D, $\frac{1}{4664}$D.
Department of Geology, University, 8499D.

Genus COSCINUM? Keyserling.

(Reise in das Petschoraland, 1846, p. 191).

Plate IV., fig. 5.

Several specimens of flattened encrusting bryozoa bear a slight resemblance to the holotype of Bretnall's *Coscinum? australe* (G.S.W.A. Bull. 88, p. 25). I can find no other specimen, figure or description which they resemble even remotely. This is probably due to there being very little literature on polyzoa available in Western Australia. I therefore record and figure these specimens as they are excellently preserved, hoping that they may be accurately identified later.

Description :—Flattened, encrusting zoarium. Zoecia arranged more or less in fluctuating rows, alternating in adjacent rows, five in the space of 3 mm. measured in any direction, apertures circular to pyriform, average diameter about ·6 mm. Lunaria strongly developed. Interspaces vesicular, the vesicles directly adjacent to the zoecia forming rings of from 10–15 large vesicles round each zoecium.

Specimen Number : Geological Survey, $\frac{1}{4591}$.
Department of Geology, University, 8493.

Genus FENESTELLA (Miller), Lonsdale.

(Murchison's Silurian System, Pt. II, 1839, p. 677. Amended by McCoy, Brit. Pal. Foss. Fasc. I, 1855, p. 49.)

Fenestella affluensa, Bretnall.

Fenestella affluensa, Bretnall, G.S.W.A. Bull. 88, 1926, p.16, pl. I, fig. 8.

An examination of the holotype confirms the presence of this species amongst the polyzoa from the Wooramel shales.

Although Bretnall says it has "a delicate zoarium" and has "little in particular to distinguish it" it seems to me distinct in being a relatively stouter form than other species of this genus, as the interstices are broader than the fenestrules and the crossbars nearly as broad as the interstices. The interstices lack a medial carina and are almost flat, not raised like those of *F. horologia* and *F. fossula.*

Specimen Number : Department of Geology, University, G on 8499.

Fenestella horologia, Bretnall.

Plate IV., fig. 3.

Fenestella horologia, Bretnall, G.S.W.A. Bull. 88, 1926, p. 15, pl. I, fig. 6.

The hourglass shape of the fenestrules described by Bretnall is very distinctive, although this is not at all apparent in his figure. The specimens agree with descriptions of *F. horologia* in all particulars except the length of the fenestrules, which in my specimens is up to ·57 mm.

The Wooramel specimens show many points of resemblance to *F. perelgans* Meek.* The very regular arrangement of the cell openings is the same ; "a pore is always situated at each end of the dissepiments and one on the interstices between, that is, on the longer side of each fenestrule." On close examination (about x 20) a row of fine accessory pores is seen making a wavy line on the crest between the two rows of zoecial apertures. "The non-poriferous side has rather a coarse longitudinal striation." Although the hourglass shape of the fenestrules is so marked in some parts of the zoaria there are other parts where the lateral margins of the fenestrules are no more waved than those shown by Waagen's, fig. 3b and 3c, of *F. perelegans.* As the "hourglass" structure is only caused by the projection of the zoecial apertures, this character alone seems scarcely enough to separate these forms from *F. perelegans* where the apertures are in exactly similar positions, but do not project quite so strongly. The fenestrules are slightly larger than in *F. perelegans* as there are only 8 in the space of 5 mm. as opposed to 10 in *F. perelegans* in the same space, measured both in the same direction as the extension of the branches and transversely. There is considerable variation in the breadth of the fenestrules from half to almost one and a-half times that of the branches, whereas in *F. perelegans* the width of the fenestrules is only half that of the branches. The larger fenestrules and proportionately thinner branches give the zoarium a more delicate appearance than that of *F. perelegans.* No longitudinal striations are discernable on the dissepiments, whereas these are present in *F. perelegans.*

Although the holotype of *F. horologia* (specimen 16 on 10930) is not to be found in the Geological Survey Collection,† the Woolamel specimens are identified as this species by the unmistakable "hourglass" shape of the fenestrules on parts of the zoaria. From other characters described above it is evident that *F. horologia* is closely related to, if not identical with, *F. perelegans* Meek.

Specimen Numbers : Geological Survey E on $\frac{1}{4688}$, $\frac{1}{4679}$ and $\frac{1}{4664}$.

Department of Geology, University, E on 8499.

* 1871 *Fenestella schumardi* Prout ? Meek in Heyden's Final Report on Nebraska, p. 153, pl. VII., fig. 3.
,, *F. perelegans* Meek ibid, p. 153, line 4 from below.
1885 *F. perelegans* Waagen Salt Range Foss. (Pal. Ind. Ser. XIII), I, 5, p. 777, pl. LXXXVII., fig. 1–3.

† A crumpled fragment of a *Fenestella* zoarium is labelled Holotype, but the distinguishing number and the greater part of the zoarium have been broken off. The remaining fragment, although slightly stouter, is very much the same as my specimen, but is too crumpled for accurate comparison.

Genus RHOMBOPORA, Meek.

(Pal. Eastern Nebraska, 1872, p. 141.)

Rhombopora mammillata, Bretnall.

Rhombopora mammillata, Bretnall, G.S.W.A. Bull. 88, 1926, p. 24, pl. I, fig. 2.

One poorly preserved piece of this species is distinguished by the prominent diagonals, dividing the surface into a regular rhombic lattice work. Bretnall's figure gives no idea of this feature, but an examination of his holotype (10930 C2) shows that it is an unmistakable characteristic.

Specimen Number: Geological Survey, H on $\frac{1}{4688}$.

Rhombopora multigranulata, Bretnall.

Plate IV., fig. 2.

Rhombopora multigranulata Bretnall, G.S.W.A. Bull. 88, 1926, p. 25, pl. 1, fig. 3.

Zoarium cylindrical up to 2 mm. in diameter. Zoecia elongately oval from ·2 to ·3 mm. in longitudinal diameter. Interstices closely set with granules. The specimens differ from *R. multigranulata* as described by Bretnall, only in dimensions. The diameter of the zoarium is slightly greater, the apertures of the zoecia are slightly longer and the interstices proportionately wider, adjacent zoecia being separated by about their own width as in Bretnall's figure.

Specimen numbers: B on $\frac{1}{4688}$ & $\frac{1}{4679}$, Geological Survey.
B on 8499, Department of Geology, University.

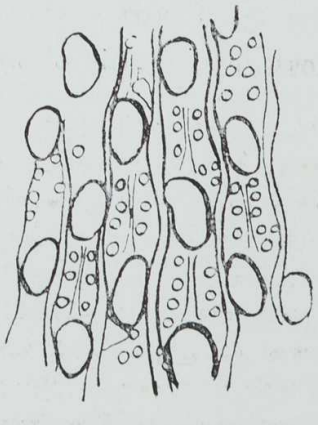
Genus STREBLOTRYPA Ulrich.

(Bull. Denison, Univ., IV., pt. 1, 1888, p. 84.)

Streblotrypa marmionensis, R. Etheridge, junior.

Plate IV., fig. 1 and Text fig. 1.

Streblotrypa marmionensis, Bretnall – Geol. Survey W.A. Bull. 88, 1926, p. 22, pl. II., fig. 3, pl. I., not fig. 1 but fig. 7 ?



Text figure 1.—Camera lucida drawing showing arrangement of zoecia and mesopores (× about 30).

Pieces of cylindrical zoaria from 1 to 2 mm. in diameter agree with Etheridge's description of this species (in Bretnall's paper) but not with his figure 1. plate 1. They show longitudinal rows of zoecia, with a longitudinal diameter of ·21 mm. arranged in quincunx, separated by longitudinal carinae the lateral margins of the zoecia practically touching the carinae and, above and below the zoecia, polygons, variable in number, containing mesopores as he describes. Plate 1, fig. 1, shows no carinae but zoecia separated by one, or sometimes two, mesopores, in this agreeing with Bretnall's description of *S. etheridgei*. Plate 1, fig. 7, labelled *S. etheridgei*, on the other hand agrees with the description of *S. marmionensis* in having the longitudinal rows of zoecia separated by dense bands which seem to indicate ridges.

Unfortunately, the holotypes of *S. marmionensis* and *S. etheridgei* are in the Australian Museum, hence unavailable, but the collection which Mr. Bretnall returned to the Geological Survey of W.A. contains specimens labelled No. 1, *S. marmionensis* and No. 5, *S. etheridgei*. Of about six or seven of No. 1, all but two agree with the Wooramel examples, which are therefore called *S. marmionensis*. There is only one specimen labelled No. 5. This is quite distinct and could not be represented by Plate 1, Fig. 7. I would suggest, therefore, that the titles to the figures 1 and 7 were transposed in the press and that fig. 7 is *S. marmionensis*.

Specimen Numbers : Geological Survey C on $\frac{1}{4688}$ & $\frac{1}{4679}$.
Department of Geology, University, 8499C.

Genus SULCORETEPORA D'Orbigny.

(Prod. Palaeont. I., 1850, p. 152 ; for complete synonomy see G.S.W.A. Bull. 88, p. 16.)

Sulcoretepora meridianus, R. Etheridge, junior.

Sulcoretepora meridianus, Eth. jun. Bull. 88, 1926, p. 19, pl. 1, fig. 9.

A small portion (I on specimen 8499) from the south bank of the Wooramel, below Callytharra Spring, agrees with the holotype of this species.

PHYLUM BRACHIOPODA.

Genus AULOSTEGES Helmersen.

(Bull. Acad. Sci. St. Petersb. 1847, VI., p. 135.)

Aulosteges ingens, n. sp.

Plate V., figs. 1a–c, Plate VI., figs. 2a–c.

Description :— Shell slightly longer than broad ; ventral valve inflated, dorsal valve flat in the visceral region, but becoming concave towards the edges which are abruptly bent upwards, more or less at right angles to the plane of the valve. In the longitudinal direction the ventral valve is strongly arched anteriorly and posteriorly, but slightly flattened in the visceral region. Transversely the lateral slopes ascend steeply almost at right angles to the plane of the central portion which is flattened and depressed in the central line by a well developed sinus. The hinge is slightly shorter than the greatest width of the shell. The lateral margins meet the hinge in a

blunted right angle ; they are almost straight posteriorly then curve rapidly to the anterior margin which is only very gently curved and slightly indented medially by the sinus ; thus the shell has a pronounced quadrangular outline particularly from the dorsal aspect. The umbo of the ventral valve is high, slightly overturned and slightly twisted. One specimen bears a flattened mark of attachment to some foreign body. The area is high and unequally developed on the two sides of the pseudodeltidium. The distortion of the umbo and area varies in the two specimens. On both specimens the margin on one side of the area slopes at a constant angle from the umbo to the end of the hinge line, but on the other side descends steeply nearly to the hinge line with only a very narrow prolongation of the area running to the end of the hinge line. One specimen has the abruptly narrowed side on the right, the other has it on the left of the pseudodeltidium.

The less weathered specimen shows the area ornamented with vertical striations. The pseudodeltidium is strongly vaulted with a median ridge, which, in the less weathered specimen, is rounded, but in the more weathered specimen is sharp, making the pseudodeltidium A-shaped in cross section. It is about 3 mm. broad at the base and tapers to a point under the umbo. It is marked with horizontal annulations. Where the area is much distorted the pseudodeltidium is twisted to one side. The cardinal process of the dorsal valve is broadly triangular coming to a sharp point under the pseudodeltidium.

Both valves are ornamented with spine bases which are finer and more closely set on the dorsal than on the ventral valve. On the visceral portion of the ventral valve they are large and regularly arranged in more or less alternating rows. The spines evidently ran for some distance in the test before emerging at the surface, particularly towards the anterior where this produces a faintly ribbed appearance on the exfoliated shell. Faint longitudinal grooves on the cast are also probably caused by this. Stout tubular spines are thickly set around the margin and on the ears of the ventral valve. A few concentric growth lines are faintly seen on the visceral portion of the ventral valve and towards the margin of the dorsal valve.

Where the shell has been removed showing the cast the muscle scars stand out as strongly and irregularly grooved patches slightly posterior to the centre of the shell. The internal characters of the dorsal valve are not exposed, but the septum can be seen through the shell extending over two-thirds of the length of the valve.

Dimensions :—

	I.	II.
Length of ventral valve	59 mm.	....
Length of dorsal valve	45 ,,	....
Breadth	54 ,,	over 46 mm.
Thickness of combined valves	30 ,,	31 ,,
Hinge line	42 ,,	43 ,,
Height of area	9 ,,	9·5 ,,

Remarks : The only Aulosteges previously recorded from Western Australia is *A. baracoodensis*, Eth. jun.*. Judging by the shells included in this species by its author (see references 2 and 3 footnote) the limits of *A. bara-*

* 1903 *A. baracoodensis*, Eth. jun. Geol. Survey W.A. Bull. 10, p. 22, pl. II., fig. 1–2.
1906 *A. baracoodensis* var. *septentrionalis*, Eth. jun. Official Contrib. Pal. S. Aus. No. 55, 1906, Suppl. to Parliamentary Paper No. 55 (1906) 1907, p. 5.
Exclude 1914 *A. baracoodensis*, Eth. jun. Geol. Survey W.A. Bull. 58, p. 33, pl. IV., fig. 11–13.

coodensis are very hard to define. It seems almost impossible to exclude from the species any large Aulosteges which bears spines. On the other hand, I cannot reconcile the specimen before me with the description and figure of the type of the species.

The main differences are :—

Etheridge's type of *A. baracoodensis.*	*A. ingens.*
Rotundo-quadrate	More quadrate
Convexity of low degree	Convexity of high degree with very steep sides
Cardinal margins much shorter than greatest width of shell	Cardinal margins very little shorter than greatest width of shell
Cardinal angles obtusely rounded	Cardinal angles—right angles
Umbo blunt and barely overturned	Umbo overturned, slightly overhanging hinge line
Area not distorted ; ½ to 1/3rd width of cardinal margin	Area slightly distorted ; the broad part 2/3rds to 6/7ths width of cardinal margin, but a narrow extension right to the end of the hinge line
Delthyrium high and linear	Delthyrium high but triangular.

A. ingens bears a general resemblance to a specimen of *A. dalhousi* figured by Waagen, Salt Ra. Foss. (Pal, Ind. 1884), pl. LXIII., 1a–c, but differs from the type of *A. dalhousi* (Davidson, Q.J.G.S., 1862, xviii., p. 33, pl. 2, fig. 7a and b), in being longer than wide, having the area less reclined and the hinge line proportionally longer.

Aulosteges ingens approaches nearest to an Indian specimen figured and described by Diener (Pal. Ind., 1903, Himalayan Fossils, Vol. I., pt. 5, p., 182, pl. VIII., figs. 13a–c) as *A.* cf. *gigas* Netschajew. This has a strongly convex ventral valve with the umbo slightly overturned, and the area curved. The dorsal valve is quadrangular, but no mention is made of upturned margins. Its dimensions are very similar to those of *A. ingens*, but it is slightly longer in proportion to its breadth. In addition to the ornamentation of spine bases, *A.* cf. *gigas* has a series of strong concentric wrinkles and also fine concentric striations. Neither of the specimens of *A. ingens* shows the complete shell, but the portion of shell which is seen shows only inconspicuous growth lines high on the visceral region. The umbo and area of *A.* cf. *gigas* are erect and not twisted, the deltidium is rounded with parallel margins, whereas that of *A. ingens* is tapering and in cross section is a pointed arch. *A. ingens*, therefore, although closely allied to the Indian species, differs in :—

(1) the proportionately greater breadth ;
(2) the up-turned margins of the dorsal valve ;
(3) the unequal development of the area ;
(4) the slightly twisted umbo ;
(5) the shape of the pseudo deltidium ;
(6) the absence of concentric ornamentation.

Specimen Numbers : Geological Survey $\frac{1}{4955}$ and $\frac{1}{5000}$.

Aulosteges spinosus, n. sp.

Plate III, figs. 7 a–d.

Description.—A single specimen of a ventral valve is placed in the genus *Aulosteges* as it has a large area and a cardinal margin devoid of teeth.

The shell is small, as wide as long. The specimen is actually slightly wider than long, but as the anterior margin is slightly broken, the small difference would be easily made up were this margin entire. Valve is gently

convex, not at all swollen, greatest convexity posterior to the middle of the shell. A very faint, broad, shallow sinus appears towards the anterior margin. Umbo moderately high and not overturned. A faint mark on the umbo may be the point of attachment to some foreign body. Area is broad, extending the whole length of the cardinal margin ; height about one-fifth of the length at the cardinal margin ; slightly concave ; not distorted ; under low magnification shows numerous growth lines. A very distinctive feature is that the cardinal margin is recurved and erect so that a deep groove lies between it and the area proper. There is a narrow, highly arched pseudodeltidium which extends only half the distance to the cardinal margin, leaving a large open delthyrium widening considerably towards the cardinal margin where it is over 2 mm. across. The pseudodeltidium, under low magnification, shows a few growth lines, but no trace of spine bases.

The whole outer surface, other than the top of the umbo, is thickly covered with small perforated tubercles representing spine bases. On the slightly worn surface the spines can be seen as fine white lines running for considerable distances through the shell substance before emerging at the surface.

Internal characters.—An extraordinary feature of this shell is that although the specimen is well preserved and has been well cleaned, no definite traces of muscle scars can be observed. There are two very ill-defined rounded depressions, one on either side of the median line, about half-way to the anterior margin, and in these depressions are a few scattered pits. These marks are far too vague for any importance to be attached to them, unless later material shows them more definitely. Numerous irregular ridges lie on the inside of the shell, extending from the margin radially inwards for varying distances. Posteriorly some taper off imperceptibly, others terminate abruptly in a more or less bulbous end. These have no connection with the ornamentation of the outside of the shell directly behind them, but bearing in mind that the anterior margin of the specimen is broken, one may suppose that they represent spines which would have emerged from the exterior surface further towards the anterior margin or from the margin itself. On the other hand, the ridges present much the same appearance as the ridged and grooved surface of the muscle scars in the other Aulosteges in the collection, so here may represent portion of the muscle scars. In this case the shell must have been considerably longer.

Dimensions.—

Length	20 mm.	incomplete
Breadth	22 ,,	
Depth of single valve	about 7 ,,	
Length of cardinal margin	15 ,,	
Height of area	3 ,,	

Remarks.—The present specimen agrees with *A. baracoodensis* (recorded from the Wooramel River, G.S.W.A. Bull. 10, p. 22, pl. II, fig. 1–2a) in having a faint sinus in the ventral valve, the umbo blunt and barely overturned, the area not distorted and no spines on the deltidium. It differs in all other respects, viz.: it is a much smaller shell and was probably not longer than wide ; its cardinal margin is not " much shorter than the greatest width of the shell " but only a little shorter ; the cardinal angles are not rounded ; the area is not so high and is broader ; the deltidium is shorter, leaving a large open delthyrium ; the ornamentation is of finer spines more closely set and regularly arranged ; finally there are no concentric latilaminae.

The ornamentation of *A.* spinosus is more like that of specimens from north of Barrabiddie figured by Etheridge as *A. baracoodensis*, G.S.W.A.,

Bull. 58, p. 33, pl. IV, figs. 11, 12, and 13. Figure 13 shows the cardinal margin of the ventral valve which is apparently slightly recurved as in the present specimen. Etheridge's specimens are, however, much bigger, strongly convex shells on which the area is very small. Both specimens bear very little likeness to the type of *A. baracoodensis* and have been removed by Dr. Whitehouse to "*Taeniotheris*," a new genus of productids with *P. subquadratus* as type (Aust. Assn. Adv. Sc. Perth, 1926, p. 282, footnote 3, and p. 283, footnote 4). In any case the two points of resemblance between these and *Aulosteges spinosus* are not enough to reconcile the latter with Etheridge's description of the type of *Aulosteges baracoodensis.**

A. spinosus differs from the type of the genus, *A. wangenheimi*, de Vern† mainly in the height of the umbo and the area on the ventral valve. Those of the latter are much higher and sharper and slightly distorted.

A. dalhousi Davidson‡ is, perhaps, the nearest to *A. spinosus* in shape and ornamentation. The main differences are: *A. dalhousi* has a pronounced sinus, *A. spinosus* only a faint one; in *A. dalhousi* the area is strongly reclined, making an angle of only a little more than a right angle with the plane of junction of the two valves, in *A. spinosus* the area is more erect and is not vertically striated as in *A. dalhousi*; the pseudodeltidium in *A. dalhousi* reaches nearly to the hinge line and is coated with small spines; *A. dalhousi* has not the recurved cardinal margin of *A. spinosus*.

The differences from all described species are so pronounced that the present *Aulosteges* must be placed in a new species despite there being only one specimen in the collection.§

It is to be noted, however, that the characters in which this specimen differs from *A. igens* (see p. 15) are all such as may change during growth, viz.: size, fineness of ornamentation, size of area, size of pseudodeltidium, distortion of umbo and area and irregularity of the shell. It is possible, therefore, that *A. spinosus* may represent the young form of *A. ingens*. In the absence of intermediate forms the differences between them are too pronounced to allow their inclusion in the one species, especially as they came from different horizons, *A. ingens* from the Deltopecten horizon and *A. spinosus* from the Irwin horizon.

Specimen Number: $\frac{1}{4687}$ Geological Survey.

Genus CHONETES Fischer 1837.

(Oryctographie Gouv. Moscou, 1837, p. 13[illegible].)

Chonetes pratti, Davidson.

1859 *Chonetes pratti* Davidson, Geologist, p. 116, pl. 4, figs. 9–12.
1892 „ „ Bull. Newton, Geol. Mag. IX (3), p. 542, pl. XIV.

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*A. *baracoodensis* var. *septentrionalis*, Eth. jun. from Northern Territory, described in Official Contrib. Pal. S. Austr. Suppl. to Parliamentary Paper No. 55 of 1906, p. 5 and 6 shows no characters in common with *A. spinosus*.

† *Orthis wangenheimi*, de Vern, Murchison's Geol. Russia in Eur. 1845, ii, p. 194, pl. 11, fig. 5a. and b.
Aulosteges Davidson, Brit. Foss. Brach. Pal. Soc. 1853, i, (Introd.) p. 116, pl. 9, figs. 212–215, id. Geinitz Dyas, 1861, p. 95, pl. 17, figs. 20 a–f.

‡ Quart. Journ. Geol. Soc. 1862, xviii., p. 33, pl. 2, figs. 7a and b.
Waagen, Salt Ra. Foss. (Pal. Ind.) 1884, i., pt. 4, p. 662, pl. 63, figs. 1 a–c.

§ Another specimen with all the same characters has recently been found in a collection from Fossil Cliff, Irwin River.

1903 *Chonetes pratti* Eth. jun., Geol. Survey W.A. Bull. 10, p. 23.
1907 ,, ,, ,, ,, ,, 27, p. 31, pl. VIII, fig. 2, pl. IX, fig. 7, pl. X, fig. 2.
1914 ,, ,, ,, Geol. Survey W.A. Bull. 58, p. 36.

There are numerous specimens of this well known species showing variations in form from that in which the hinge line forms the greatest width of the shell to one in which the greatest width is 20 mm. half-way towards the anterior margin, but the length of hinge line is only 15mm. There is also considerable variation in convexity of the ventral valve (up to 9 cm. in a valve whose length is 15 cm.) and in the depth of its median sinus. On some of the smaller more convex specimens the sinus is inconspicuous or altogether absent.

Specimen Numbers: Department of Geology, University, 8489, 8502. Geological Survey, $\frac{1}{4684}$, $\frac{1}{4672}$, $\frac{1}{4657}$, $\frac{1}{4988}$.

Genus CLIOTHYRIDINA Buckman.*

(Ann. & Mag. Nat. Hist. Ser. 7, Vol. 18, p. 321, 1906.)

Genus CLEIOTHYRIS King.

(Mon. Perm. Foss. Eng. 1850, p. 137.)

(*Cliothyridina* =) *Cleiothyris macleayana*, B. Etheridge, junior.

1889 *Athyris macleayana*, Eth. jun., Proc. Linn. Soc. N.S.W., iv. (2), p. 208, pl. 17, fig. 1–5.
1890 *Athyris macleayana*, Foord Geol. Mag., vii (3), p. 149, pl. 7, fig. 3, p. 150, figs. B & C.
1903 *Cleiothyris macleayana*, Eth. jun., Geol. Survey W.A. Bull. 10, p. 16, pl. III, fig. 10–20.
1907 ,, ,, ,, Geol. Survey W.A. Bull. 27, p. 21.
1914 ,, ,, ,, Geol. Survey W.A. Bull. 58, p. 23, pl. I, fig. 7.

This species is very plentiful at several localities on the Wooramel River. Most of the specimens are slightly crushed, but otherwise excellently preserved, showing the long spines fringing the lamellae. Two ventral valves show the variation in size of the muscle impressions noticed by Etheridge (Bull. 10, p. 17). One has a very marked septum and much elongated impressions as seen in Foord's fig. C., whereas the other has a much less conspicuous septum and much broader cardinal impressions.

Specimen numbers: Geological Survey $\frac{1}{4686}$, $\frac{1}{4671}$, $\frac{1}{4650}$, $\frac{1}{4677}$ and $\frac{1}{4965}$ Department of Geology, University 8488, 8498, 8504.

* S. Weller in "Mississippian Brachiopoda," State Geol. Surv., Illinois Mon. 1, 1914, p. 472, follows Buckman's use of *Cliothyridina* instead of *Cleiothyris*, King on the grounds that the name *Cleiothyris* was originally proposed by Phillips and if used at all must be used as a synonym of *Athyris*, over which it has priority.

Genus DIELASMA King.

(Dublin Natural History Review vol. VI, p. 519, 1859.)

Dielasma cymbaeformis Morris.

Plate VI., figs. 1a–1d.

1845 *Terebratula cymbaeformis* Morris in Strzlecki's Physical Descr. N.S. Wales & Van Dieman's Land, p. 278, pl. XVII., figs. 4, 5.

1877 *Terebratula sacculus* var. *cymbaeformis* Morris, de Kon. Foss. Pal, Nouvelle Galles du Sud. pt. 3, p. 257, pl. 15, fig. 4 (Mem. G.S., N.S.W., Pal. 6, p. 201, pl. 15, fig. 4)

1878 *Terebratula sacculus* var. *hastata* (pars) Eth. jun. Cat. Austr. Foss. 1878, p. 61.

1892 *Dielasma cymbaeformis*, Eth. jun., Geol. and Pal. Qld. Etheridge and Jack, p. 225, pl. 9, fig. 10 and 11.

A large example of this shell bears out Etheridge's opinion (Geology and Palaeontology of Queensland, p. 225) that *D. cymbaeformis* Morris is distinct from *D. hastata* Sby. and should be maintained as a separate species. The accompanying figures show the main distinguishing features of the species. The ventral valve is strongly curved longitudinally, but transversely flattened so that the valve is very shallow for its size. The umbo overhangs that of the dorsal valve. The foramen is large and obliquely placed. The dorsal valve is longitudinally almost straight but strongly arched transversely. There is no sinus in the ventral valve. The shell is ornamented with concentric growth lines.

Dimensions :	Length	60 mm.
	Length of dorsal valve	52 ,,
	Breadth	36 ,,
	Thickness	29 ,,
	Diameter of foramen	6–8 mm.

The specimen is unfortunately slightly crushed, but apart from the crushing the shell seems to have been unevenly developed. On the crushed side the shoulder of the ventral valve is high, on the other side the shoulder is much lower than figured by Morris or Etheridge. It the shell were equally developed with both shoulders low it would differ from *D. cymbaeformis* in having the greatest breadth further towards the anterior, but as the crushing does not seem to have affected the ventral valve, I hesitate to attribute to this cause the high shoulder of the ventral valve on one side and hence to separate the specimen from *D. cymbaeformis*. The inequality is probably due to irregularity of growth showing that the height of the shoulders is a variable feature.

Specimen Number : Geological Survey $\frac{1}{4644}$.

Dielasma sp.

There are several small specimens of this genus in the collection, but they are too crushed or otherwise damaged for specific determination.

Specimen Numbers : Geological Survey $\frac{1}{4662}$.
Department of Geology, University, 8494.

Genus PRODUCTUS, J. Sowerby.

(Mineral Conchol. 1814, i, p. 153).

Four species of this genus are recorded in the accompanying list of fossils from the Wooramel River District. As the specimens show no features additional to those already described* for these well known species, no further notes are necessary. Etheridge (G.S.W.A. Bull. 27, p. 30) has already pointed out that the Western Australian Productus recorded as *P. undatus* does not "appear to resemble the more typical forms of *P. undatus*," but a revision of this species is impossible here as there are only a few imperfect specimens in the Wooramel collection.

The majority of the *Producti* belong to the species *tenuistriatus* var *foordi*, Eth. jun. These are very fine specimens, up to 28 mm. in length and similar breadth, thus larger than the average individuals from the Irwin River beds.

Specimen Numbers :

	Geological Survey.	Department of Geology, University.
P. semireticulatus Martin	$\frac{1}{4691}$, $\frac{1}{4668}$, $\frac{1}{4654}$	8496.
P. subquadratus Morris	$\frac{1}{4655}$.	
P. tenuistriatus var *foordi* Eth. jun.,	$\frac{1}{4685}$, $\frac{1}{4690}$, $\frac{1}{4669}$, $\frac{1}{4656}$,	8487, 8495, 8505.
P. undatus Defrance	$\frac{1}{4667}$, $\frac{1}{4677}$, $\frac{1}{4689}$.	

Genus RETICULARIA McCoy.

(Synop. Carb. Lime Foss. Ireland, 1844, p. 142.)

Reticularia lineata Martin.

1858 *Spirifer lineata* Davidson Brit. Carb. Brach. Vol. ii, pt. V., p. 62, pl. xiii, figs. 1–13.

1890 *Reticularia lineata* Foord Geol. Mag. dec. III., vol. VII., p. 153.

1903 ,, ,, Eth. jun. Geol. Survey, Bull. 10, p. 16.

1907 ,, ,, ,, ,, ,, ,, 27, p. 29.

(for complete synonymy, see Foord & Davidson, above).

The collection contains one ventral valve and two fragments of Reticularia. The ventral valve shows the typical ornamentation of *R. lineata* but is slightly wider than long, and has a well marked sinus thus corresponding to Davidson's description of *R. lineata* var. *elliptica* Phillips.

Specimen Numbers : $\frac{1}{4674}$, $\frac{1}{4661}$.

*See G.S.W.A. Bulletins, 10, 27 and 58.

Genus SPIRIFER J. Sowerby.

(Mineral Conchol. 1816, II., p. 41.)

Spirifer byroensis ? Glauert.

1912 *S. byroensis* Glauert, Rec. W.A. Museum, Vol. I., pt. II., p. 75.
1914 ,, ,, Eth. jun. Geol. Survey W.A. Bull. 58, p. 25, pl. IV., fig. 10 ; pl. V., fig. 5 ; pl. VI., figs 1–5.

A limonitic cast of a compressed elongately triangular shell with a low dorsal fold and traces of fasciculate ribbing may be a cast of the above species. It differs from the cast of *S. rostalinus* described on pages 26-27 in the shape of the process representing the muscle cavity. This is high but narrowed to a point, whereas that of the cast of *S. rostalinus* is broad and bluntly truncated.

Specimen Number : Geological Survey $\frac{1}{4694}$.

Spirifer hardmani Foord.

1890 *Spirifer hardmani* Foord, Geol. Mag. Dec. III, Vol. VII., p. 146, p. 146, pl. VII., fig. 1, 1a.
1903 ,, ,, Eth. jun. Geol. Survey W.A. Bull. 10, p. 14, pl. 1, figs. 6 and 7, pl. 2, figs. 7–9.

Two incomplete ventral valves ornamented with radiating ribs and three or four ill-defined folds on each side of the sinus may be referred to this species. Etheridge remarks on the likeness of this ornamentation of *S. hardmani* to that of *S. musakheylensis*. In the latter, however, the bundles are more marked and in the Australian variety at least the central rib of the bundle is stronger than the others, whereas in *S. hardmani* the ribs are more or less equal. In the ill-defined character of the bundling *S. hardmani* is more like *S. ravana* Diener (Himalayan Foss. (Pal. Ind.) I, pt. 4, 1897, p.34, pl. III, figs. 1 and 2) but from this and from *S. marcoui* Waagen, Etheridge (G.S.W.A. Bull. 53, p. 24) distinguishes it by the length of the cardinal margin, which in *S. hardmani* is less than the greatest width of the shell. This is shown by one of the Wooramel specimens.

Specimen Numbers : Geological Survey, $\frac{1}{4659}$. (a)
Department of Geology, University 8490 (a).

Spirifer fasciger Keyserling = *Spirifer musakheylensis* Davidson.

Plate VII., figs. 1–3.

For reference and discussion of synonymy of *S. fasciger* and *S. musakheylensis* see :—

Diener, Himalyan Foss. (Pal. Ind.) 1897, i., Pt. 3, p. 43 ; pt. 4, p. 35 ; 1899, pt. 2, p. 63 and 1903, pt. 5, p. 106.
Foord, Geol. Mag., 1890, vii., dec. 3, p. 147.
Eth. jun., 1903, G.S.W.A., Bull. 10, p. 12.

Although there remains no doubt that *S. fasciger* and *S. musakheylensis* are identical and that Keyserling's name takes precedence of Davidson's, I

have retained Foord's name *S. musakheylensis* var *australis* for the Western Australian forms as this is so widely in use in Australian literature and collections.

Several incomplete specimens in the collection show considerable variation in the sharpness of the folds forming the bundles of ribs. One specimen is figured to show the sharp apical angle compared with that of *S. rostalinus* below. A specimen showing the interior of the ventral valve (fig. 2) is of interest as it helps to identify numbers of *Spirifer* casts. The muscle impressions are deep but do not extend far up into the beak which is filled with massive calcareous material. On the other hand the shell on either side of the dental plates just below the area is not very much thickened. The effect on the cast (shown by fig. 3, plate I of a plasticine impression) therefore, will be that the process representing the cavity for the muscles will be stout but will not project beyond the lateral portions of the cast.

Specimen Numbers : Geolgical Survey $\frac{1}{4659}$, $\frac{1}{4680}$ and $\frac{1}{4963}$.
Department of Geology, University 8490.

Spirifer rostalinus, n. sp.

Plates VIII., VIIIA, IX., X. and XI., figs. 1 and 2.

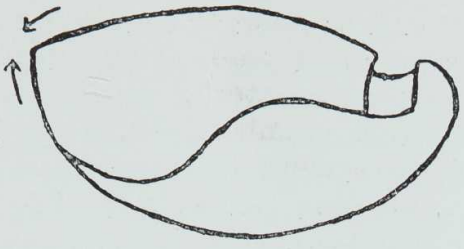
Spirifer casts Etheridge jun., Geol. Survey W.A., Bull. 58, p. 28, Nos. 1 and 2, pl. III., figs. 2 and 3, pl. V., figs. 3 and 4.

The very large series of Spiriters described below is remarkable for the extreme variation in shape from a compressed elongated shell such as fig. 7, pl. VIIIA, to a stout form such as fig. 2, pl. VIII. and fig. 1a–d, pl. IX. After an examination of about thirty specimens and about twenty casts I find there is a continuous gradation from one shape to the other. As it is unlikely that collecting in other localities will yield such well connected series it may be convenient to separate the more alate and the stouter forms as two varieties, simply to give an easy means of reference. In this case, I suggest, the alate forms should be called *S. rostalinus* var. *auritus* and the thicker, less triangular forms *S. rostalinus* var. *crassus*.

The gradation from one form to the other is the effect of increase with advancing age in length and depth without a proportionate increase in breadth. If on one of the stouter forms the earlier growth lines are examined they will be seen to outline an alate form agreeing in every particular with specimens of the variety *auritus* such as fig. 7, pl. VIIIA.

The outline of the more alate forms is elongately triangular, the breadth being over two and a-half times the length. In the stouter forms growth at the anterior and antero-lateral margins has been more pronounced than at the postero-lateral margins, so that the breadth in these specimens is less than twice the length. As growth of the antero-lateral portion is so pronounced, the margin, instead of being straight, becomes curved and the shell seen from the dorsal surface is almost semi-circular in outline. This is not shown by most of the figures as these were taken looking vertically down on the fossils. Figure 1a, plate IX, however, taken with the shell tilted backwards slightly, shows this outline, which at first glance seems to constitute a striking difference between these and the more alate specimens. The greater depth shown by the larger forms is also the effect of growth.

During growth the anterior margins of the valves are curved towards one another and as each valve grows towards the margin of the other, the two are pushed farther and farther apart.



Text figure 2.

Diagram to show the direction of growth of the valves causing increase in depth with age.

Although these changes in outline take place during growth the more alate shells are not always the smaller as apparently some change their outline at a later stage than others, for example, fig. 4, pl. VIIIA. shows a large shell of the variety *auritus* and fig. 8, pl. VIIIA. a smaller shell of the variety *crassus*.

The shells are ornamented with radial ribs grouped into bundles. This grouping dies out towards the wings and towards the anterior margin. It is much more marked in some specimens than in others ; in one it is only to be seen on the umbonal flanks, others have strong bundles which must have been even more marked on unweathered specimens. From three to five ribs form a bundle. Near the umbo the centre rib of each bundle is stronger than those on either side. As the bundles die out the ribs become more delicate and equal. Most of the specimens are exfoliated and have the ends of the wings devoid of ribs, but a few of the better specimens have faint ribs extending almost, if not quite, to the tips of the wings. Both the fold and the sinus are ribbed. The surface of the shell was probably covered with concentric " frill lamellae " such as those of *S. musakheylensis*. These are indicated on the worn surfaces of the shells by innumerable fine fibrous lines parallel to a few stronger growth lines. External impressions accompanying the limonite casts mentioned below also show the presence of these raised frilled lamellae.

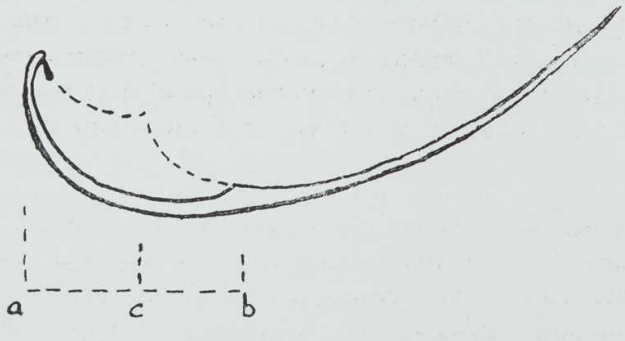
The valves are about equally inflated. Their convexity has already been referred to in dealing with changes taking place during growth. In the ventral valve the curvature is stronger longitudinally than transversely. The transverse curvature varies in different specimens : the alate forms are almost flat transversely, but as growth proceeds the margin is bent dorsally so that in the larger specimens the curve is much more pronounced. The sinus is broad, but varies in depth in different individuals. In some of the alate forms it is quite shallow, but in the larger forms it is pronounced causing the anterior margin of the valve to bend sharpely forward. On the umbo it is limited by folds, but anteriorly the limits become indistinct. On the umbo a single rib lies in the sinus. Extra ribs appear by interpolation so that at the margin of a small specimen there are about eight ribs in the sinus. These multiply until, in a large specimen, there are a considerable number, possibly between 15 and 20. Unfortunately, none of the large specimens is well enough preserved to show the limits of variation in the number of ribs lying in the sinus. The central rib which commences high on the umbo is stronger than the rest. This is well shown by several of the

smaller specimens, see fig. 7b, pl. VIIIA. One of the large specimens shows this pronounced rib bifurcating at about half the distance to the anterior margin, giving rise to two ribs equal in size to the others lying in the sinus.

The dorsal valve is very variable in curvature. Longitudinally the lateral parts may be flattened or strongly convex. The curvature increases with age. The fold is strong and elevated considerably above the general convexity of the shell. On either side of this the shell is flattened transversely, but towards the wings tends to curve upwards. This is noticed on only one of the smaller shells on which the lateral portions are usually almost flat transversely. It is a common feature of the larger shells, showing that it is acquired with age. The dorsal fold commences as a high plain rib but other ribs are added by interpolation, so that at the margin the fold bears about twenty ribs. Of these, five on each side belong to a bundle of ribs flanking the primary fold high on the umbo. None of the specimens shows distinctly whether the crest of the fold is a median rib more pronounced than the rest or whether all the ribs are approximately equal. To all appearances, however, the central rib is pronounced at first, but towards the anterior is split up into two subsidiary ribs equal in size to those on either side.

Both umbos are very small, scarcely raised above the upper margin of the area, so that the valves have a very wide apical angle. The area of the dorsal valve is narrow and flat with parallel margins. That of the ventral valve is broad, gently reclining, concave, and has nearly parallel margins. It is marked vertically with wavy striae and horizontally with straight growth lines. The delthyrium is very broad and is closed in for less than one-third of its length by a deeply sunken deltidium which is flattened laterally, but has a raised median ridge.

In the interior of the ventral valve the depression for the muscle attachments is very deep and extends high up under the umbo. In the region of this depression the shell is comparatively thin. On either side of the dental plates the shell is very much thickened, all that portion behind the area of the ventral valve being filled in with calcareous material. On the cast the effect of this is that the process representing the cavity for the muscle impressions is very stout and very much elevated above the body of the cast, see text fig. 3, which explains the apparent anomaly of a shell with such a low umbo being identified with casts mentioned below, on which the prominent cast of the muscle cavity seems to indicate a high umbo on the shell.



Text figure 3.

Showing relation of section of the shell through the umbo to a section (shown by dotted line) taken on the other side of one of the dental plates where the shell is solid behind the area. Thus the distance a–b represents the length of the cast of the muscle cavity and distance a–c its elevation above the cardinal margin of the cast.

A single specimen in the collection serves to connect a large series of limonitic casts from Bogadi Outcamp with the shells described above. This specimen has the typical dorsal valve of *S. rostalinus*, but the ventral valve has been removed showing the high cast of the muscle cavity referred to above which is so characteristic a feature of the series of limonitic casts. see pl. X. and pl. XI, figs. 1 and 2. These are particularly interesting as they establish the identity of casts described by Etheridge, G.S.W.A. Bull. 58, p. 28, Nos. 1 and 2, pl. III, fig. 2 and 3, pl. V, fig. 3 and 4. They show the same variation in shape as the testiferous specimens and include forms such as Etheridge's No. 1 as well as more alate forms such as his No. 2. The fasciculate ribbing is always better shown on the dorsal valve of the cast. On the ventral, the ribbing is only shown towards the anterior margin. On the visceral portion the surface of the cast is covered with tiny granulations on either side of the strong muscle impressions.

Dimensions of a typical Series of Shells :—

	I.	II.	III.	IV.	V.	Type of *Spirifer byroensis.*
Length of shell	63 mm.	52 mm.	over 41 mm.	37 mm.	26 mm.	37 mm.
Length of dorsal valve	51 ,,	45 ,,	,, 34 ,,	32 ,,	22 ,,	27 ,,
Length of hinge line	100 ,,	95 ,,	94 ,,	78 ,,	70 ,,	97 ,,
Thickness of both valves* ...	41 ,,	34 ,,	29 ,,	25 ,,	17 ,,	21 ,,
Apical angle of ventral valve† ...	158°	157°	157°	156°	abt. 150°	158°
Apical angle of dorsal valve ...	142°	144°	144°	149°	abt. 146°	...
Height of area of ventral valve ...	11 mm.	8 mm.	7 mm.	4 mm.	...	9 mm.
Height of area of dorsal valve ...	2 ,,	2·5 ,,.	...	...	...	...

Remarks.—These shells are allied to *S. nitiensis* Diener** and to *S. musakheylensis* Davidson§ and form a series parallel to that shown by Diener (Himal. Foss. I, pt. 5, p. 106 and 107) to exist between these two species.

The alate forms of *S. rostalinus* are closely comparable to *S. nitiensis*. Diener's description of the type of *S. nitiensis* gives the " breadth three times the length." He later modifies this, describing further specimens in 1903. The specimens before me exhibit proportions between those of his type of 1897 and the specimens figured in 1903. The ribbing is similarly grouped in bundles, but, in *S. nitiensis*, Diener describes ten fasciculi on either side of the fold or sinus before the bundling dies out. These, however, are in distinguishable in his figures in which, as in our specimens, only three or four bundles are at all well marked. There is a similar strong rib in the centre of the sinus and the fold is similarly costate. The only other character by which *S. nitiensis* may be distinguished from *S. rostalinus* var. *auritus* is the prominence of the umbo. Although the umbo of *S. nitiensis* is " but slightly produced beyond the cardinal edge " that of *S. rostalinus* is even less produced, and makes a gentle slope continuous with the slope of the posterior edge of the area, so that the apical angle is very wide, 150° to 160°, in contrast with that of the type of *S. nitiensis* in which the apical angle is 144°.

The low umbo and wide apical angle again are the main features separating the larger members of *S. rostalinus* from *S. musakheylensis* in which the apical angle is only 130°. The young shells of *S. rostalinus* differ markedly from those of *S. musakheylensis*. In the younger forms of *S. musakheylensis* the hinge line is always shorter than the greatest breadth of the shell. The

* Measured from fold to point opposite in the sinus.

† Measured only on rostral portion ; the apical angle of the ventral valve, measured from end to end of the hinge line, is between 161° and 166°.

***S. nitiensis* Diener Himalayan Foss. Pal. Ind. 1897 I, pt. 4, p. 41, pl. IV, fig. 4 and 5 a–e ; 1899 I, pt. 2, p. 65, pl. V, fig. 9 ; 1903 I, pt. 5, p. 106, pl. IV., fig. 6–7.

§ Waagen Salt Ra. Foss. (Pal. Ind.) 1883, I, pt. IV, Fas. 2, p. 512, pl. 45 and previous references.

growth lines of *S. rostalinus* outline a very alate form in which the breadth is over twice the length and show that even in the earliest stages the hinge was never shorter than the greatest breadth of the shell. The majority of Waagen's figures show the transverse convexity of the ventral valve less than that of the dorsal, whereas in these specimens the conditions are reversed. In many specimens the convexity of the ventral valve transversely is further accentuated by the upward curve of the wings of the dorsal valve This also causes a difference in the line of junction of the two valves as seen from the side, compare text fig. 2 with Waagen's figs. 1c and 2c. The only Spirifer in which I have seen a similar upward lifting of the wings of the dorsal valve is *S. marcoui*, figured by Diener, Himalayan Foss., Pt. V, pl. IX. fig. 1d. *S. marcoui* has been recorded from Western Australia by Etheridge, G.S.W.A. Bull. 58, p. 23, pl. 1, figs, 5–6, pl. 2, figs. 8–9, but this is easily distinguished from *S. rostalinus* by the character of the ornamentation which is much finer in *S. marcoui*. *S. rostalinus* has only about 60 or 70 ribs grouped into bundles whereas *S. marcoui* has about 120 ribs with only very slight traces of bundling.

Another Spirifer which may be compared with the alate variety of *S. rostalinus* is the Western Australian *S. byroensis* Glauert.* Mr. Glauert has kindly allowed me to examine his types of this species (W.A. Museum, Nos. 1650 and 1651). From these I find there is more likeness to *S. nitiensis* and hence to the Wooramel specimens, than would be supposed from Etheridge's detailed description and comparisons. According to Etheridge the ornamentation of *S. byroensis* shows less "tendency to fasciculation" than that of *S. nitiensis*, thus agreeing with *S. rostalinus*, although as I have remarked above, the figures of *S. nitiensis* do not show fasciculation to the extent described by Diener. Etheridge also says that the alar extensions of *S. byroensis* are ribless. Those of *S. rostalinus* are possibly ribbed. The presence of ribbing on the wings in *S. byroensis* is just as debatable as in *S. nitiensis* and in *S. rostalinus*. I have examined the specimens described by Etheridge and find that in three of these and in Mr. Glauert's types the wings are obscured by a film of limonite ; in another specimen, the original of pl. V, fig. 5, G.S.W.A. Bull 58, although the ribs become very much fainter, they are still to be seen on the wings, even though the shell here is slightly worn. Bearing in mind that the more delicate ribs are lost in slightly worn specimens, it seems possible to use this point in separating species only when excellent specimens are available. Again, the prominence of the sinus and fold of *S. byroensis* is doubtful. Etheridge says "the depth of the sulcus is much less and the brachial fold is less prominent in *S. byroensis* (than in *S. nitiensis*). In consequence of this the anterior wave of the united valves is straighter and there is an absence of the strong forward median projection of *S. nitiensis*." The half specimen shown on pl. V, fig. 5, Bull. 58, certainly has a flat fold and no median projection, but as Mr. Glauert's types and all the other specimens identified by Etheridge are unfortunately crushed and considerably damaged at the margin and, among these, one or two undoubtedly show the beginning of a high fold, it is impossible to say whether or not the low fold and absence of median projection are variable features.

Apart from these debatable points the only constant differences between *S. byroensis* and *S. nitiensis*, namely, the height of the umbo and the size of the apical angle, are the same as those separating *S. nitiensis* from *S. rostalinus* var. *auritus*. The apical angle of *S. byroensis* is 158° measured

*S. *byroensis* Glauert Rec. W.A. Museum, 1912, Vol. I., pt. II., p. 75.
,, ,, Etheridge G.S.W.A. Bull. 58, 1914, p. 25, pl. IV, fig. 10, pl. V., fig. 5, pl. VI., figs. 1–5.

at the rostal portion, or 165° measured from end to end of the hinge line. In this as in most other characters it agrees with *S. rostalinus*, from which it is to be distinguished only by its extreme elongation transversely, the compression of the united valves and possibly a shallower fold. The measurements of the type of *S. byroensis*, number 1650, are given on page 27, for comparison with those of *S. rostalinus*.

It is probable that *S. byroensis* belongs to the same group as *S. rostalinus* but represents a form in which growth with old age takes place more at the cardinal margins than at the anterior margin, thus accentuating the alate form of the shell. It will be interesting to see whether further collecting shows the presence of forms intermediate between *S. byroensis* and the alate *S. rostalinus*. If these are present two series of variations with advancing age may be shown starting from *S. rostalinus* var. *auritus*, varying in the one direction to a progressively stouter shell, *S. rostalinus* var. *crassus*, and in the other direction to a progressively broader form, *S. byroensis*, which is more compressed in proportion to its breadth, owing to slower growth at the anterior margin. As there are no intermediate forms in the collection before me, I cannot unite these specimens with *S. byroensis* Glauert, but must separate them as a new species.

Summarising the characteristics of *S. rostalinus* these are : exceptionally low umbo, wide apical angle, broad area with almost parallel margins, pronounced fold and sinus both ribbed, coarse ribs grouped in bundles near umbo, 4–5 bundles each side of fold or sinus, bundles dying out towards anterior and on wings.

Specimen Numbers : $\frac{1}{4640}$ and $\frac{1}{4692}$ Geological Survey.
$\frac{1}{4949}$ almost complete series ,, ,,
Var *crassus* $\frac{1}{4649}$,, ,,
8480, 8483, 8477, Department of Geology, Univ.
Var *auritus* $\frac{1}{4641}$ and $\frac{1}{4693}$. Geological Survey.
8484, 8975, and 8976, Department of Geology, Univ.

Genus SPIRIFERELLA Tschernyschew.

(Mém. Comité. Géol. Russie, 1902, XVII., No. 2, pp. 121, and 522.)

Spiriferella australasica, R. Etheridge, junior.

1899 *Cyrtina carbonaria* var. *australasica*, Eth. jun. Proc. Linn. Soc. N.S.W. IV. (2), p. 210, pl. XVII., fig. 6–8.
1907 ,, ,, ,, ,, Eth. jun. Bull. G.S.W.A. No. 27. p. 21.
1914 *Spiriferella australasica* Eth. jun. Geol. Survey W.A. Bull. No. 58, p. 30, pl. V., fig. 6–13.

Numbers of specimens of this species are present in the collection but none of these have the outermost shelly layer preserved to show whether or not this is punctate.

Specimen Numbers : Geological Survey, $\frac{1}{4658}$, $\frac{1}{4666}$, $\frac{1}{46\sim1}$, $\frac{1}{4691}$, and $\frac{1}{4964}$.
Department of Geology, University, 8497.

Genus STROPHALOSIA King.

The specimen recorded on the locality chart as a member of this genus, registered as Geological Survey Specimen $\frac{1}{46}$, was in an excellent state of preservation and undoubtedly represented a new species. It has since been lost, therefore description and figures are worthless until further specimens are available.

PHYLUM MOLLUSCA.

CLASS LAMELLIBRANCHIATA.

Genus CARDIOMORPHA de Koninck.

(Anim. Foss. Terr. Carb. Belg. 1842, p. 101.)

Cardiomorpha blatchfordi, n. sp.

Plate VII., figs. 4a and 4b and fig. 5).

Pachydomus? Eth. jun. Geol. Survey W.A. Bull. 58, p. 36, pl. VII., fig. 3.

Casts of an equivalve, oblique, inequilateral shell are placed in this genus as they possess an apparently edentulous hinge. The umbones are high, strongly recurved and directed forward. The line of greatest convexity runs obliquely from the umbo to the posterior ventral margin. On one side of this the shell slopes abruptly to the posterior margin, on the other side it is gently rounded with a very slight flattening towards the anterior margin. The anterior portion of the shell is narrowed. Two specimens show a very faint trace of a sinus in the anterior third of the ventral margin. The pallial line lies near the ventral margin and is without a sinus. The anterior muscle scar is pear-shaped, and deeply impressed, particularly on the posterior side, so that on casts its margin is sharp and ridge-like. The posterior muscle impression is rounded, larger and placed higher than the anterior one and is not so deeply impressed. The hinge is deeply sunk. On two casts the line of junction of the two valves immediately below the umbo has a slight twist, but the hinge plate appears to have been without teeth. A line near the posterior dorsal margin probably indicates the position of the escutcheon.

Many of the casts show a remarkably regular ornamentation of coarse concentric sulci. These are particularly well marked in the smaller specimens and are not so well marked in those showing the muscle markings. Apparently those in which it is so pronounced are more in the nature of partial replacements than true internal casts. In the larger specimens the sulci become obsolete on passing over on to the posterior slope. The only portion of shell shown adhering to one of these specimens is near the anterior margin. It is fairly thick, with an ornamentation of very fine concentric lines with three regularly spaced coarser striae. The latter probably correspond to the coarse rugae of the casts.

Dimensions :	I.	II.	III. Small individual.
Antero-posteriorly	43 mm.	51 mm.	16 mm.
Dorso-ventrally	40 ,,	48 ,,	15 ,,
Thickness	32 ,,	40 ,,	9 ,,

Remarks : The limonitic cast figured by Etheridge as *Pachydomus?* closely resembles the casts described above. Etheridge mentions a resemblance to *P. ovalis* (McCoy, Ann. Nat. Hist. 1847, XX., p. 302, pl. 14, fig. 4) which, however, differs in its regular outline, slight convexity, rounded muscle impressions, and possession of a slight pallial sinus.

Although similar shells from the Permo-Carboniferous rocks of Australia have been described by de Koninck and others under the genus *Pachydomus*, I have followed Hinde (Carboniferous Lamellibranchiata pt. III.,

p. 255 and p. 259, Pal. Soc. for 1898) in placing these in the genus *Cardiomorpha* as they lack the teeth and "antiquated area" of *Pachydomus*. At the same time, as Hinde notes, the concentric ornamentation is coarser and apparently the muscle marks are deeper than in the typical *Cardiomorpha*.

The species is named after Mr. T. Blatchford, Government Geologist, through whose kindness I have been able to examine not only this collection, but all previously identified fossils now in the Survey collection.

Specimen Numbers : Geological Survey $\frac{1}{4642}$, $\frac{1}{4946}$, $\frac{1}{4951}$ and $\frac{1}{4999}$.

Cardiomorpha, n. sp.

Plate VII., fig. 6.

A single imperfect specimen may represent the exterior of the species *Cardiomorpha blatchfordi* as it agrees fairly well in shape with the casts described above. The shell is ventricose, slightly inequilateral, with the anterior narrowed from above downwards and the anterior border semi-circular. The inferior border is slightly convex, sloping obliquely to the posterior margin which is damaged in this specimen. The body of the shell is gently rounded, but from an oblique rounded ridge on the posterior side it descends abruptly to the posterior margin. The umbones are high above the hinge line, prominent, swollen, incurved, touching one another and directed forward. The shell is thick and ornamented with fairly coarse concentric ridges which are pronounced anteriorly but become obsolete as they pass on to the abrupt dorsal slope.

Dimensions :

Antero-posteriorly	more than	58 mm.
Dorso-ventrally		55 ,,
Thickness		42 ,,

Remarks : Comparing this description with that of the casts of *C. blatchfordi* one can find no distinguishing features except that the ornamentation of this shell is not what one would expect for *C. blatchfordi*. The concentric ridges are too fine to leave coarse folds and sulci on the cast. However, at fairly regular spaced intervals there are heavier concentric ridges which become more like coarse folds or wrinkles towards the ventral margin. Bearing in mind that the small piece of shell adhering to one of the above casts of *C. blatchfordi* was also finely striated with a few heavier striae it is quite possible that this specimen may be the same species. As it is found at a different horizon, unaccompanied by casts, its identity cannot be proved until further specimens are available.

In convexity and ornamentation the specimens recall *P. globosus* Sowerby,* but no figures of the latter show an abrupt posterior slope although Etheridge (Geol. and Pal. Qld., p. 283) mentioned a rounded diagonal ridge when speaking of the thickness of his specimen. The proportions differ from those of *P. globosus* in which the length from anterior to posterior is considerably greater than that from dorsal to ventral margin. On the whole the figured specimens of *P. globosus* vary so in outline that it is quite possible that this specimen could be included in the limits of the species, which, however, is not a very well-defined one since the only characters linking together the various specimens described under the name seem to be the swollen shell and the coarse concentric ornamentation.

Specimen Number : $\frac{1}{4701}$ Geological Survey.

*Megadesmus globosus Sowerby in Mitchell's Three Expedit. Interior of Eastern Australia, Vol. 1, p. 15, pl. 2.
Pachydomus ,, Morris, in Strzlecki's Phys. Descr. N.S.W., pl. X., fig. 2 and 3.
,, ,, de Koninck Pal. Foss. Nov. Galles du Sud. 1877, pt. III., p. 272, pl.18, fig. 5. (G.S.W.A. Pal. Mem. 6, p. 214, pl. 18, fig. 5).

Genus DELTOPECTEN R. Etheridge, junior, 1892.
(Geol. and Pal. Queensland and New Guinea, p. 269.)

Deltopecten subquinquelineatus, McCoy var. *comptus* Dana.

Plates XII. and XIII.

1847	*Pecten comptus* Dana		Am. Journ. Sci. (2) IV., 1847, p. 160.
1906	*Deltopecten subquinquelineatus*,		(pars) Eth. jun. and W. S. Dun. Geol. Surv. N.S.W. Mem. Pal. 5, Vol. II., pt. I., p. 26.
1907	,,	,,	Eth. jun. Geol. Survey, Bull. 27, p. 22, pl. 5, figs. 1–3.
1910	,,	,,	L. Glauert, Geol. Survey, Bull. 36, p. 91.
1914	,,	,,	Eth. jun. Geol. Survey W.A. Bull. 58, p. 36, pl. 8, fig. 1.
1929	,,	*comptus*	Fletcher, Records, Aus. Mus. Vol. XVII., No. 1, p. 23, pl. XIII., figs. 1–4.

The description below is based on an examination of a series of sixteen testiferous specimens in a sandy matrix and over forty limonite casts and partly testiferous specimens from the Wooramel District. Unfortunately, only three or four of these specimens have the margins unbroken, although they are otherwise well preserved and show hinge, ears and ornamentation very clearly.

The shell is orbicular, equilateral, inequivalve. The left valve is convex, the right valve flat or very slightly convex. The cardinal margins are less in length than the greatest antero-posterior measurement of the shell; the ratio between the two varies slightly with the size of the shell, but is about two-thirds in an individual in which the antero-posterior measurement is 3in. Antero- and postero-ventral margins are semi-circularly rounded. The hinge area of both valves is broad, showing numerous fine resilium furrows and below each umbo a broad, semicircular, concave chondrophore, concentrically striated by a continuation of the resilium furrows.

Left-Valve.—Convex, umbo moderately tumid, pointed. The ears are large wedge-shaped, flattened, almost equal, the anterior slightly larger than the posterior and separated from the body of the valve by a slightly steeper slope. On the inside of the shell where the ear joins the body of the shell there is a more pronounced ridge on the anterior side than on the posterior. This leaves a well-marked insinuation on the cast as figured by Etheridge, G.S.W.A. Bull. 27, pl. 5, figs. 1–3. The posterior ear is pointed at the dorsal margin, the anterior is bluntly rounded, with a slightly convex margin. The margin of both the anterior and the posterior ear has a broad concave insinuation just before its junction with the anterior and posterior margins of the shell. Ears and body of the shell show a few widely spaced growth lines. On the ears there are fine radiating ribs which are close and in most cases equal. On the better preserved specimens these are crossed by very fine growth lines raised into lamellae. On even slightly worn specimens however, these lamellae are lost and the ribs appear unbroken by any transverse ornamentation. On the body the ribbing is extremely variable. On the umbo one can count sixteen to twenty-two ribs, a coarser alternating with a finer. The latter, however, rapidly attain the same size as the former, so that lower on the shell they cannot be distinguished as two series. The ribs on the umbo are steeply rounded, but rapidly become broad and flattened. At the margin of the larger specimens the primary ribs are from 5–7 mm. apart. Between each of the broad primary ribs on the body of the shell, is a secondary and on either side of this a variable number of

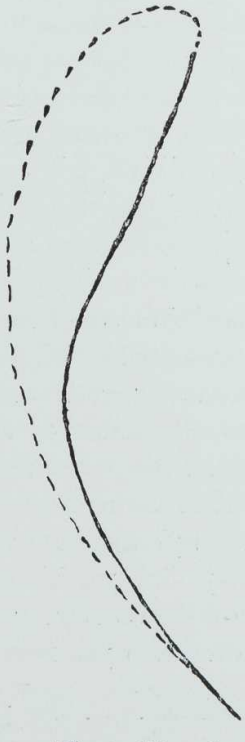
tertiary ribs. In many places the arrangement given by McCoy for *D. subquinquelineatus*—one secondary flanked by two tertiaries—is to be seen. In other parts of the shell the arrangement is quite irregular as there may be:—

(a) no tertiary ribs ;
(b) no secondary, but from two to six finer ribs ;
(c) a secondary with an unequal number of tertiaries on either side.

The coarseness of the primary ribs is also variable. Where there is only one tertiary rib between the primary and secondary, the primary ribs in many cases conform to McCoy's description of "coarse narrow rounded ridges," but on the average large specimen they are broad and flattened. On large specimens below about the third or fourth growth line, the broad primary and the larger of the secondary ribs divide up into a number of finer ones, the broader ones giving rise to as many as six fine striae, nearly equal in strength to the tertiary ribs. On the body of the shell the ribs are quite smooth without transverse striae, but near the margin of larger shells where the broad ribs are subdivided into finer ones there are indications of a concentric ornamentation of very close fine laminae. Some of the specimens are slightly exfoliated on the main body, and here the test is silky and fibrous, the fibres having a general concentric arrangement.

Right Valve.—Most of the specimens are flat. One specimen of the united valves has the visceral portion convex, but becomes flattened and slightly concave towards the margins, see text fig. 4. A similar outline is figured by Etheridge and Dun, pl. XIII, fig. 2. Two internal casts of large right valves have the visceral portion almost flat, but the marginal portions abruptly bent back and closely pressed against the left valve. Text fig. 5 shows in cross section the outline of one of these casts with the approximate position of a left valve drawn from another specimen shown by the dotted line.

Text Fig. 4.



Text. Fig. 5.

Text. figure 4.—Cross section of small specimen, showing slight concavity of right valve towards the margin.

Text figure 5.—Cross section of cast of a large concave right valve with dotted line indicating the position of the left valve.

The compression of the shell may be due to crushing, but as several smaller specimens show the beginnings of concavity around the margins of the right valve it is probable that this reversal of curvature becomes more pronounced with age. The umbo is inconspicuous. The posterior ear is broad and flat, separated from the body of the shell by only a very slight slope, and is the same size and shape as the posterior ear of the left valve. The right anterior ear is smaller than the left anterior. Its outer margin is convex and slopes abruptly backwards. It is separated from the main shell by a deep narrow byssal sinus. The surface of the right anterior ear shows raised lamellae crossing the ribs, breaking them into rows of granules. The ribbing on the right valve is much simpler than that on the left. A second series of ribs arises about half-way to the anterior margin. These rapidly attain the same size as the primary ones. On an individual, two and a-half inches long, near the margin, is a series of very fine threadlike ribs, alternating with the larger ribs. The latter are never as broad nor as flattened as the primary ribs on the left valve of the same individual. The spaces between the ribs on the right valve are broader than the ribs themselves.

Casts.—The majority of the limonitic specimens are casts. On these the ribbing is much less distinct, as is to be expected on an internal cast. Some show a few tertiary ribs, others only secondary ribs and others even only show primary ribs. Their identity with the many-ribbed testiferous specimens is proved by examining a number of partly testiferous specimens showing less pronounced ribbing on the cast in places from which the shell has been removed. The resilium area of the hinge appears narrower on the casts (Eth. jun. G.S.W.A. Bull. 27, p. 22, " hinge line narrow ") as the resilium is mostly external and therefore is not entirely shown on an internal cast.

Dimensions :	I.	II.	III. Small individual with flat right valve.	IV. Small individual with convex right valve.
Dorso-ventrally	75 mm. (approx.)	62 mm.	43 mm.	40 mm.
Antero-posteriorly	85 mm.	62 ,,	....	....
Thickness of united valves (about)....	25 ,,	18 ,,	11 ,,	14 ,,

Remarks.—The Wooramel Delotpectens agree in all essential characters with *D. subquinquelineatus* McCoy,* but show coarser ribbing than *the majority* of specimens figured under this name. Although McCoy's original figure shows the anterior ear of the left valve with a deeply convex margin meeting the anterior margin of the shell at an acute angle, no later figures of the species show† this, as most are too imperfect in the region of the ears for use in comparison. Specimens from Western Australia figured by Etheridge, G.S.W.A. Bull. 27, p. 22, pl. V, figs 1–3, and Bull. 58, p. 36, pl. VIII, fig 1, show the margin of the anterior ear with the same outline as that of the Wooramel specimens, see pl. XI, fig. 4.

The larger specimens in the present collection bear a very striking likeness in ornamentation and general outline to a coasely ribbed shell figured

*1847 McCoy Ann. and Mag. Nat. Hist. XX., p. 298, pl. XVII., fig. 1.
1906 Eth. jun. and W. S. Dun, Geol. Survey of N.S.W. Pal. Mem. 5, Vol. II., pt. I., p. 26, pl. III., fig. 2, pl. IX., figs. 1–5, pl. XII., figs. 2 and 3, pl. XIII., figs. 2 and 8, pl. XIV., fig. 1.
1929 H. O. Fletcher, Rec. Aust. Mus. Vol. XVII., No. 1, p. 30, pl. XV.

† I have not seen that given by Etheridge, Proc. Roy. Phys. Soc. Edin. 1880, V., p. 297, pl. 13, fig. 52.

by Fletcher under the name *D. comptus* Dana. Fletcher's fig. 1 shows the outer margin of the anterior ear rounded, whereas in the Wooramel specimens the anterior margin of the ear meets the dorsal margin at a blunted angle, varying from an acute to almost a right angle. As the growth lines on Fletcher's specimen show exactly the same curvature as those on the Wooramel specimens, where the outer margin is parallel to the growth lines, it seems likely that the margin of Fletcher's specimen is imperfect. Fletcher states that the posterior ear is larger than the anterior. This is scarcely shown by the figure unless the indefinite shaded area is all ear. The shape outlined by the heavy growth line is the same as that outlined by growth lines and margin on the W.A. specimens.

Fletcher also says the anterior ear shows primary and secondary ribs, whereas the posterior shows equal ribbing. On the Western Australian specimens the ribbing on the ears is variable ; some show a few ribs on the anterior ear stronger than others as on Fletcher's specimens ; others show equal fine ribbing. The ribbing is stronger on the anterior ear than on the posterior, hence it is preserved on the anterior when that on the posterior has been worn off.

On the whole, I can find no definite means of distinguishing the Wooramel specimens, either from *D. subquinquelineatus* McCoy or from *D. comptus* Dana. Dana's species had been included by Etheridge & Dun, Mem. G.S. of N.S.W. Palaeontology, No. 5, ii., I., 1906, p. 26, as a synonym of *D. subquinquelineatus*, but Fletcher says of his specimen : "This is a definite coarsely ribbed form and so unlike *D. subquinquelineatus* that I have no hesitation in re-establishing Dana's specimens." Later he says : "its ornamentation definitely separates it from *D. subquinquelineatus*," *i.e.*, he excludes coarsely ribbed forms from the species *subquinquelineatus*. There are two objections to this. Firstly, McCoy's original *D. subquinquelineatus* is by no means finely ornamented. He describes the primary ribs as "rather coarse narrow rounded ridges" and his figure gives the impression of a fairly coarse ornamentation, certainly coarser than that figured by later writers as this species (*e.g.* Eth. jun. Pal. Mem. G.S. of N.S.W., No. 5, Vol. II., pt. I., pl. IX., figs. 1 and 2 or Fletcher, Records Australian Museum, XVII., No. 1, pl. XV., fig. 4). Secondly the suite of sixty specimens from the Wooramel exhibits all stages between a very coarsely ribbed form, such as Fletcher's *D. comptus* and one in which the primary ribs are only half this width at the same distance from the umbo and no coarser than those of McCoy's original figure. For these reasons I do not think the species *D. comptus* can stand as there are no other features distinguishing it from *D. subquinquelineatus*. On the other hand, were a large number of specimens not available to show the gradual variation in coarseness of ornamentation, forms such as Fletcher's pl. XIII., fig. 1, and some of the Wooramel specimens would seem strikingly different from what is apparently taken by Etheridge & Fletcher as the typical *D. subquinquelineatus*. Therefore, it seems advisable to distinguish the coarser ribbed forms as variety *comptus* of McCoy's species.

Previous records in W.A.—Fletcher, p. 25, records a specimen of *D. comptus* from east of Mingenew, W.A. In Geological Survey Bulletin 27, Etheridge described three limonitic casts from Mingenew under the name *D. subquinquelineatus*. These, and another from Byro Station (Geol. Surv. Bull. 58) are exactly similar to the limonitic casts from Bogadi Outcamp and have, therefore, been included in the synonmy above.

Specimen Numbers: Geological Survey $\frac{1}{4697}$, $\frac{1}{4698}$, $\frac{1}{4699}$, $\frac{1}{4643}$, $\frac{1}{4648}$, $\frac{1}{4945}$ and $\frac{1}{4948}$.

Department of Geology, University, 8479, 8482, 8475 and 8476.

Genus PARALLELODON, de Koninck.

A fragment registered as $\frac{1}{4682}$ Geological Survey is recognised as belonging to this genus from its likeness to specimens obtained from near Holmwood Station in the Irwin River District. The specimen comes from the south bank of the Wooramel R. below Callytharra Springs and is found with an assemblage of fossils typical of those occurring in the Irwin River Valley.

CLASS GASTROPODA.

Genus PTYCHOMPHALINA (Bayle) Fischer 1885.

(Man. Conchyl. et Pal. Conchyl. Fas. 9, 1885, p. 850).

Ptychomphalina maitlandi, R. Etheridge, junior.

1903 *P. maitlandi* Eth. jun. G.S.W.A. Bull. 10, p. 24, pl. I, figs. 13–15.
1914 ,, ,, ,, ,, ,, 58, p. 37.

The collection contains a number of specimens of this species, which is easily recognised by its stout conical form and the sutural position of the band on the posterior whorls.

Specimen Numbers: Geological Survey $\frac{1}{4647}$, $\frac{1}{4648}$, ?$\frac{1}{4696}$, and $\frac{1}{4959}$.
Department of Geology, University, 8485, 8481.

CLASS PTEROPODA.

Genus CONULARIA Miller.

Conularia, cf *C. warthi* Waagen.

Plate XI., figs. 3–6.

1886 *C.* cf *irregularis* (Kon.) Waagen, Rec. Geol. Surv. Ind. Vol. XIX., p. 26, pl. 1, fig. 2 (non C. irregularis Koninck)
1889–91 *C. warthi* Waagen, Salt Ra. Foss. (Pal. Ind.) Vol. IV., p. 126, pl. IV., figs. 6a–d, pl. V., figs. 1a–b.
1912 *C.* sp. nov.? cf. *C. warthi* (Waagen) Glauert, Rec. W.A. Museum, Vol. I., Pt. II., p. 76.

The present collection contains fragments identical with those from Byro Station described by Mr. Glauert, but includes also two much better specimens enabling me to add a little to his description. The specimens are elongated, conical pieces, one 45 mm. in length with an apical angle of 16°, the other 75 mm. in length with an apical angle of 20°. Both are rhombic in section with one diameter longer than the other. One specimen is considerably more compressed than the other, probably due to crushing. This would account for its greater apical angle. At each of the corners is a furrow and in the middle of each side a faint groove.

The ornamentation is of transverse ridges, ten or eleven in 10 mm., becoming more crowded towards the apex. The ribs bend up slightly as they descend into the side furrows and alternate on either side of the furrow. They ascend to the middle of each side where they may alternate or merely be interrupted at the middle groove. The crests of the ribs are ornamented by fine granulations. In *Conularia warthi* the granulations are connected by fine irregular plications extending across the spaces between the ribs.

Neither specimen is well enough preserved to show the shell in the spaces between the ribs. On one portion where a little shelly material is preserved the plications may be seen descending the sides of the ridges so that it may well be supposed that they are continuous across the valleys between ridges.

Conularia warthi is further characterised by the presence of a row of intercostal tubercles on each side of the lateral furrows. Their presence cannot be ascertained on either of these specimens owing to their imperfect preservation.

The only definite character in which these differ from *C. warthi* is the greater apical angle, 16°—20° as opposed to 12° in *C. warthi*.

Specimen Numbers : Geological Survey $\frac{1}{4645}$, $\frac{1}{4695}$.
Department of Geology, University 8478.

EXPLANATION OF PLATES.

PLATE III.

All figures are natural size, unless stated otherwise.

Fig. 1.—**Clisiophyllum talboti,** n. sp.—1a. Geol. Survey Specimen $\frac{1}{4962}$.
1b. Same specimen looking down into calyx. Secondary septa seen at top and right of figure.

Fig. 2. ,, ,, ,, Weathered specimen showing twisting of septa on false columella.

Fig. 3. ,, ,, ,, Geol. Survey Specimen $\frac{1}{4660}$.
(a) side view, (b) dorsal view, (c) showing oval cross section, rudimentary septa shown on right side of figure.

Figs. 4–6.—*Plerophyllum australe,* Hinde, showing longitudinal and transverse ornamentation.

Fig. 7.—**Aulosteges spinosus,** n. sp., ventral valve.
7a, dorsal view ; 7b, ventral view ; 7c, side view ; 7d, outline drawing from 7c enlarged four diameters to show pseudodeltidium and upturned cardinal margin.

PLATE IV.

Fig. 1.—*Streblotrypa marmionensis,* Eth. jun., microphotograph of portion of zoarium (x20).

Fig. 2.—*Rhombopora multigranulata,* Bretnall, do. do.

Fig. 3.—*Fenestella horologia,* Bretnall do. do.

Fig. 4.—*Aetomacladia ambrosoides,* Bretnall, microphotograph of portion of zoarium at intersection of one of cross branches (x20).

Fig. 5.—*Coscinum ?* .... Microphotograph of portion of zoarium (x20).

PLATE V.

All figures are natural size.

Aulosteges ingens, n. sp. .... 1a. Geol. Survey specimen $\frac{1}{5000}$, ventral view ;
1b. dorsal view ;
1c. side view to how convexity, outline of umbo very irregular due to unequal weathering of the shell.

PLATE VI.

All figures are natural size.

Fig. 1.—*Dielasma cymbaeformis*, Morris, 1a, ventral view ; 1b, dorsal view ; 1c, left side showing low shoulder ; 1d, right side showing high shoulder.

Fig. 2.—**Aulosteges ingens**, n. sp. .... Geol. Survey Specimen $\frac{1}{4955}$; 2a, dorsal view ; 2b, ventral view ; 2c, cross section of broken specimen showing convexity and abrupt sides of ventral valve and upturned margins of dorsal valve.

PLATE VII.

All figures are natural size.

Fig. 1.—*Spirifer musakheylensis* var. *australis*, Foord. Geol. Survey specimen $\frac{1}{4963}$.

Fig. 2.— ,, ,, ,, Foord. Geol. Survey specimen $\frac{1}{4963}$. Interior of portion of ventral valve. Area broken off.

Fig. 3.— .... Plasticine cast of above specimen showing size of cast of muscle cavity.

Fig. 4.—**Cardiomorpha blatchfordi**, n. sp. Geol. Survey Specimen $\frac{1}{4999}$. Cast of combined valves. 4a, anterior view showing raised, pear-shaped muscle impression ; 4b, left valve showing entire pallial line and faint concentric folds.

Fig. 5.— ,, ,, ,, Geol. Survey Specimen $\frac{1}{4951}$. Cast.

Fig. 6.—**Cardiomorpha**, n. sp.

PLATES VIII. AND VIIIA.

All figures are natural size.

Figs. 1–7. **Spirifer rostalinus**, n. sp. Series showing gradual change in proportions.
Figs. 1 and 2 : *S. rostalinus* var. *crassus* ; figs 5–7, *S. rostalinus* var. *auritus* ; 7b, dorsal valve of specimen ; 7a, showing prominent rib in sinus ; 7c, anterior view of same specimen ; figs. 3 and 4, intermediate forms.
Geol. Survey Specimens $\frac{1}{4949}$, and Department of Geology University Specimen 8975

Fig. 8.—**Spirifer rostalinus** var. **crassus**, small specimen.

PLATE IX.

All figures are natural size.

Fig. 1a.—**Spirifer rostalinus** var. **crassus**, n. sp. and var.—Same specimen as plate VI., fig. 2, tilted slightly backwards to show semi-circular margin.

Fig. 1b.— ,, ,, ,, Dorsal view of same specimen.

Fig. 1c.— ,, ,, ,, Posterior view of same specimen.

Fig. 1d.— ,, ,, ,, Anterior view of same specimen.

PLATE X.

All figures are natural size.

Figs. 1a–c.—**Spirifer rostalinus** var. **auritus**, n. sp. and var.—Cast Department of Geology, specimen 8505, Byro Station. 1a, ventral valve; 1b, dorsal valve; 1c, anterior view.

PLATE XI.

All figures are natural size.

Figs 1 & 2.—**Spirifer rostalinus** var. **crassus**, n. sp. and var.—Casts Department of Geology Specimens 8477. Compare Geol. Survey Bull. 58, pl. III, figs. 2 and 3, plate V, figs, 3 and 4.

Fig. 3.—*Conularia* cf. *C. warthi*, Waagen. Impression showing ornamentation, Geol. Dept., Specimen 8478.

Figs. 4 & 5 ,, ,, ,, Two views of Geological Survey specimen $\frac{1}{4645}$.

Fig. 6 ,, ,, ,, Geol. Survey specimen $\frac{1}{4695}$, slightly crushed.

PLATE XII.

All figures are natural size.

Fig. 1.—*Dellopecten subquinquelineatus*, McCoy, var. *comptus*, Dana. Geol. Survey Specimen $\frac{1}{4643}$. Left valve showing posterior ear.

Fig. 2. ,, ,, ,, var. *comptus*, Dana. Department of Geology, specimen 8482. Left valve showing anterior ear.
(umbo repaired in plasticine.)

Fig. 3 ,, ,, ,, var. *comptus*, Dana.
Portion of right valve of specimen $\frac{1}{4643}$ (which is seen over top of left valve in fig. 1) showing flat posterior ear.

PLATE XIII.

All figures are natural size.

Fig. 1.—*Deltopecten subquinquelineatus*, McCoy, var. *comptus*, Dana.
Right valve of small specimen 8482, Department of Geology, showing simple ornamentation, slight slope to posterior ear and byssal sinus at junction of anterior ear.

Fig. 2 ,, ,, ,, var. *comptus* Dana.
Small right valve, Geol. Survey specimen $\frac{1}{4948}$, showing shape and ornamentation of anterior ear.

Fig. 3 ,, ,, ,, var. *comptus* Dana.
Department of Geology Specimen 8482. Left valve showing simpler ribbing than Plate X, figs. 1 and 2.

Fig. 4 ,, ,, ,, var. *comptus* Dana.
Department of Geology Specimen 8482. Left valve showing shape of umbo and ears, posterior one very slightly chipped.

Fig. 5 ,, ,, ,, var. *comptus* Dana.
View of hinge of combined valves of specimen figure Plate X, fig. 2. Shows broad hinge plates with semicircular chondrophores.

Fig. 6.—*Deltopecten subquinquelineatus*, McCoy, var. *comptus* Dana.
Department of Geology Specimen 8476. Impression of right valve showing simple ribbing, anterior ear and byssal sinus. (Corrugated portion in position of posterior ear is a portion of a Conularia.) The ventral margin of the specimen dips steeply away from the observer, *i.e.*, specimen is convex, see unbroken line text fig. 5, but perspective is lost owing to dark colour of the specimen.

Plate III.

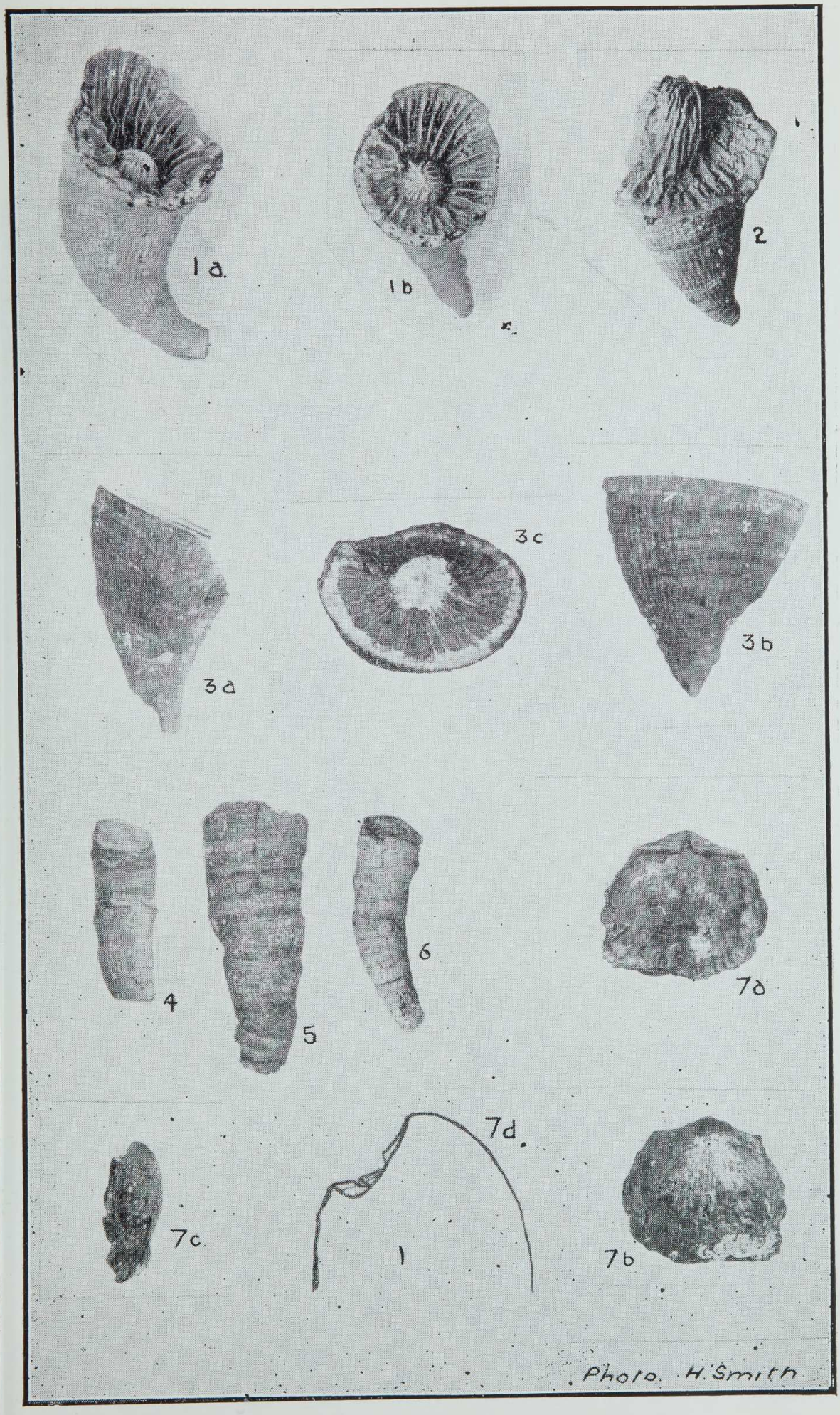


Plate IV.

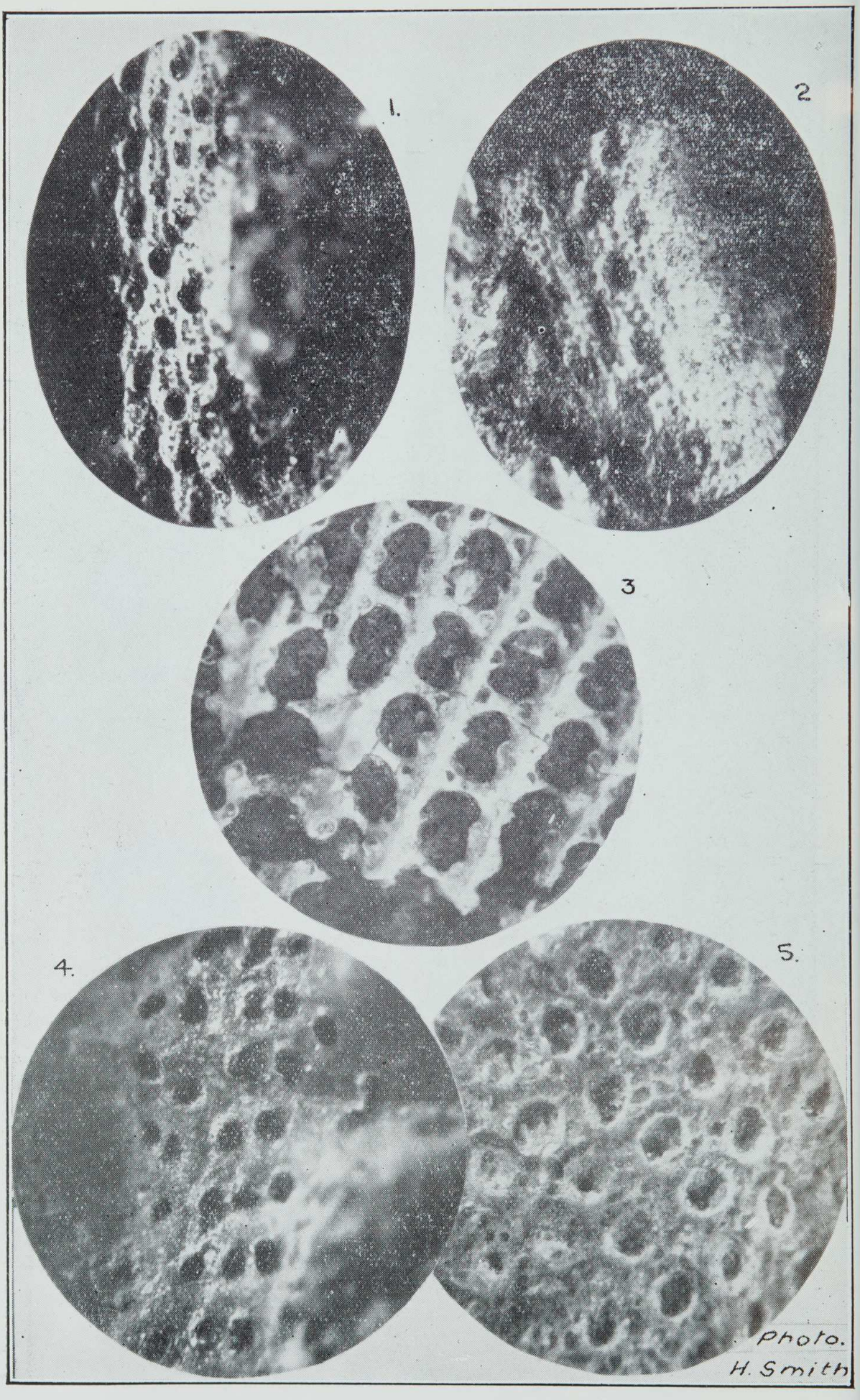


Plate V.

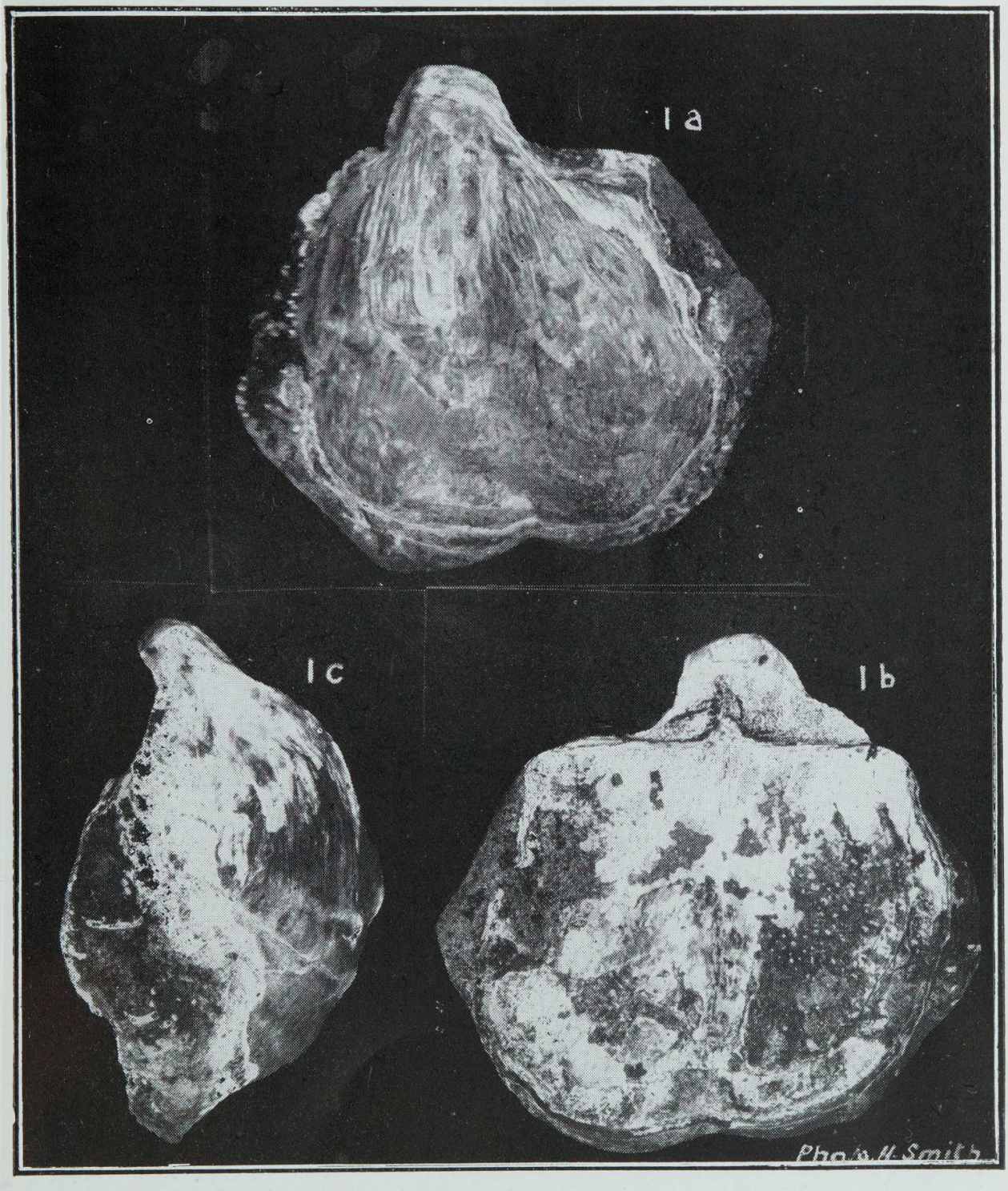


Plate VI.

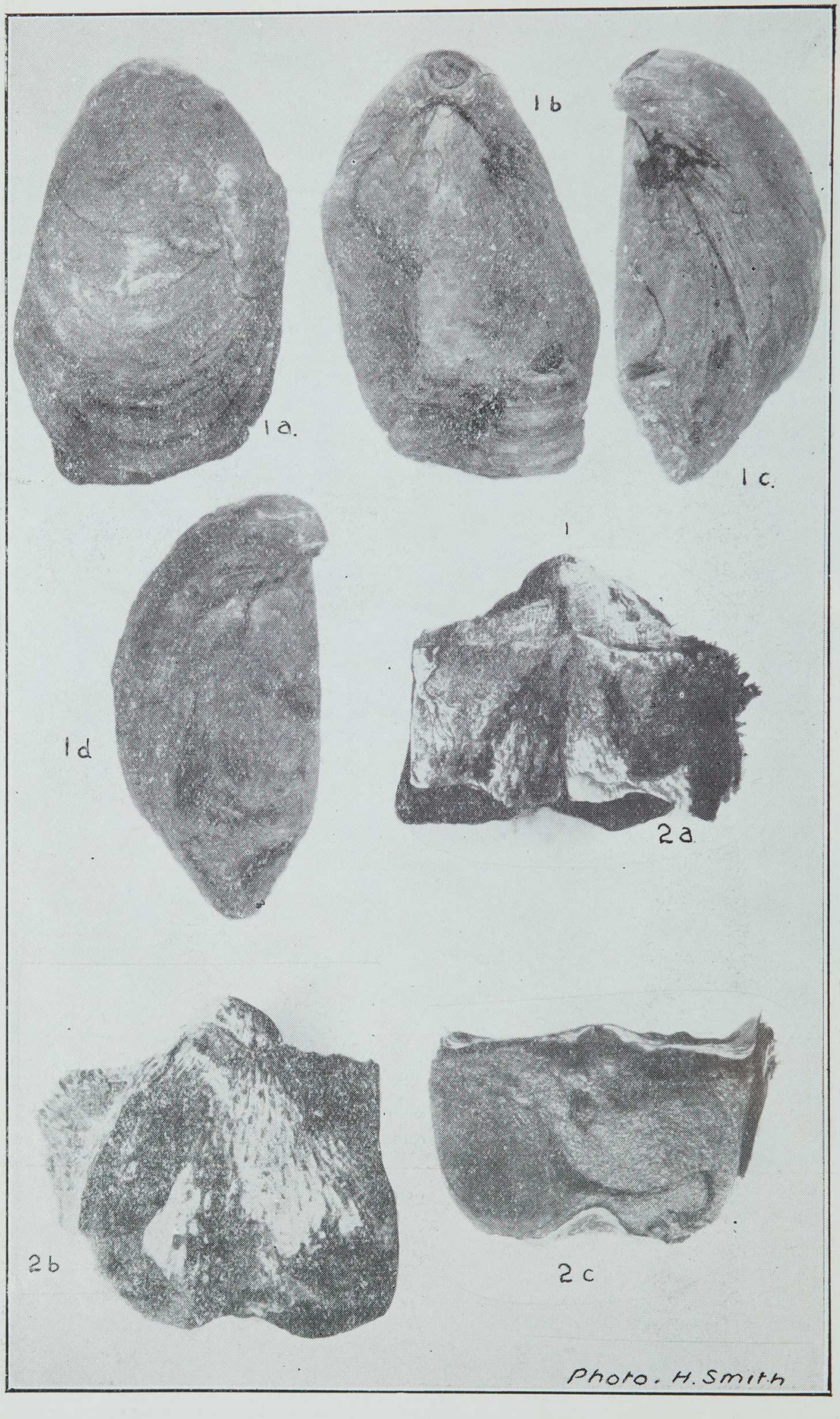


Plate VII.

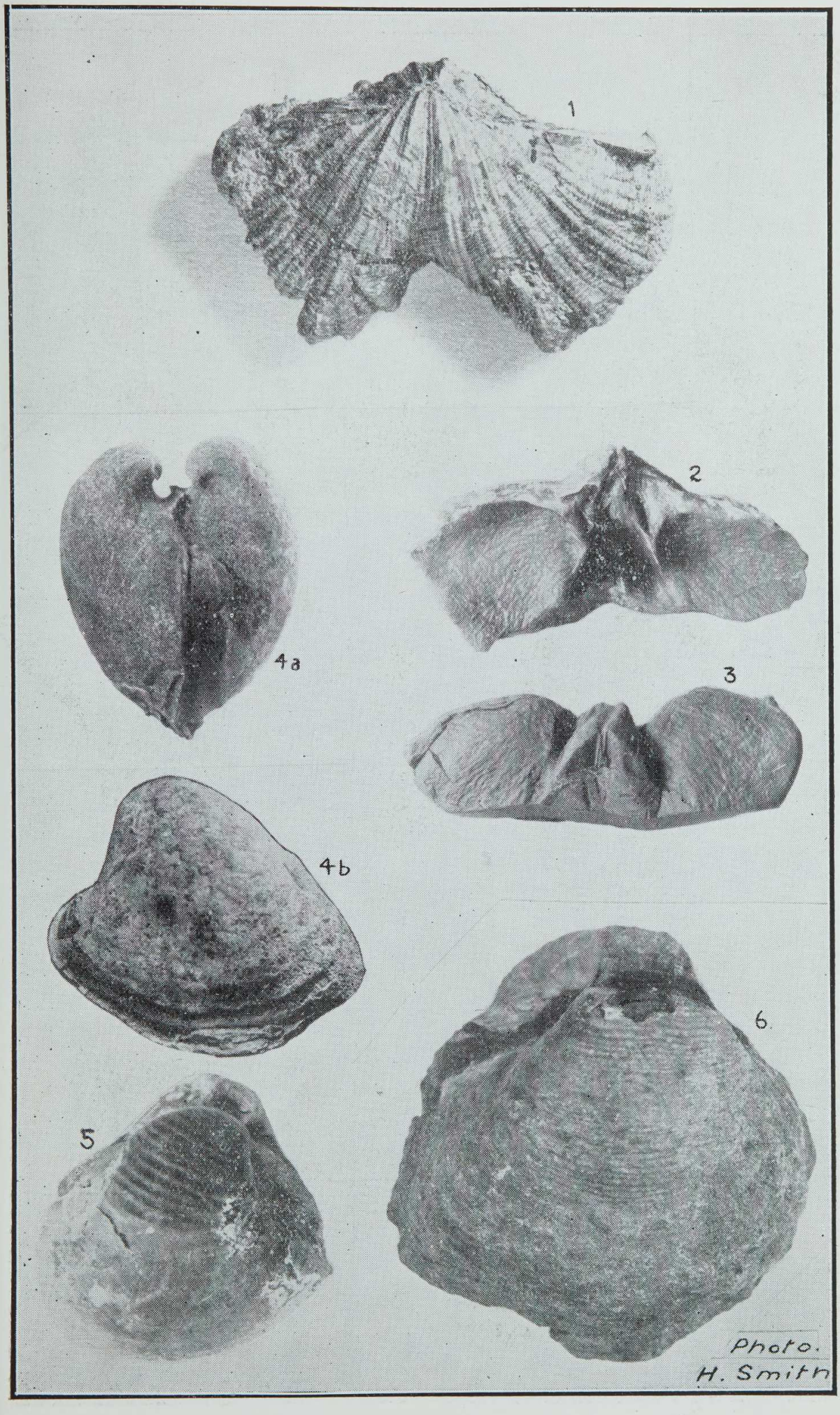


Plate VIII.

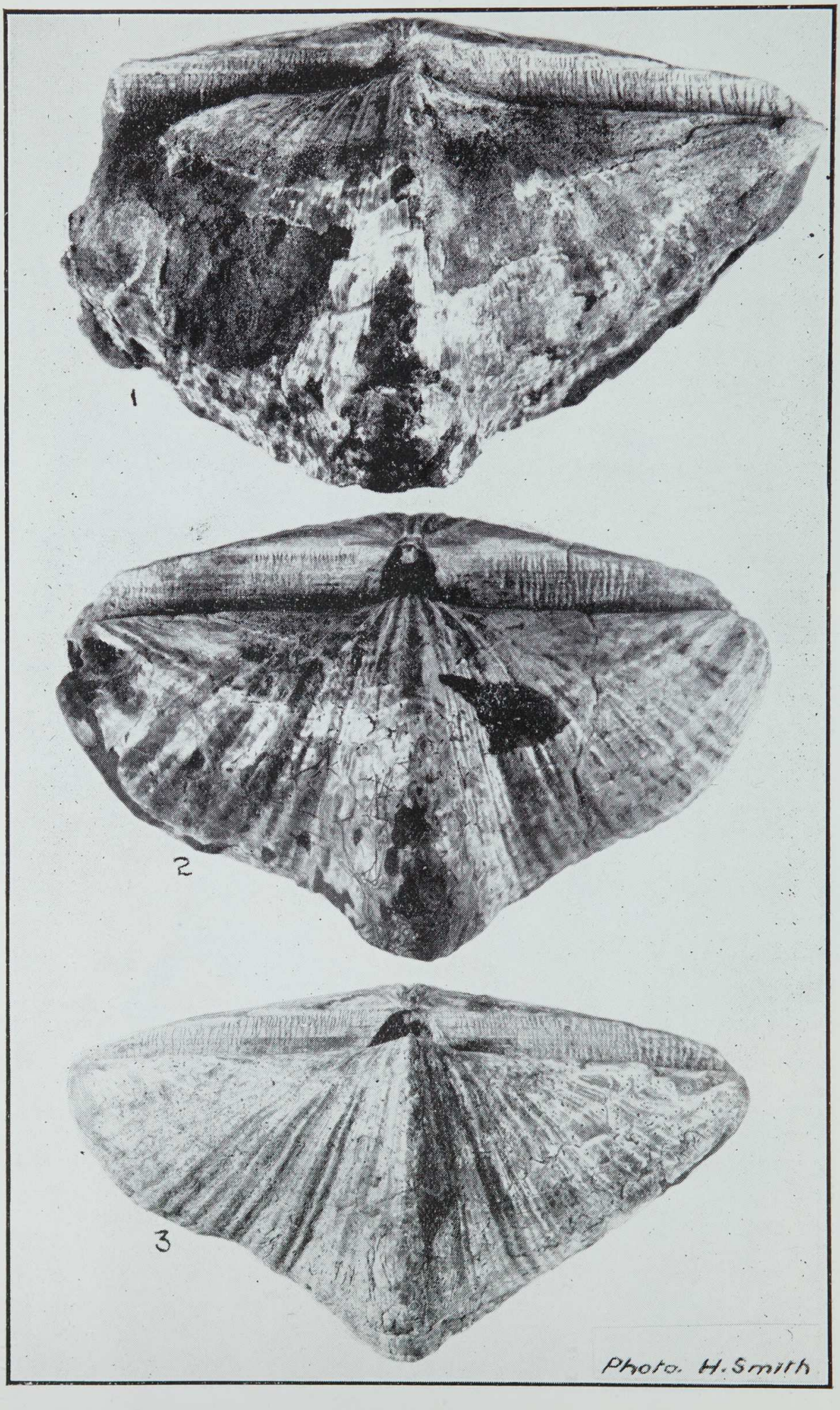


Plate VIIIa.

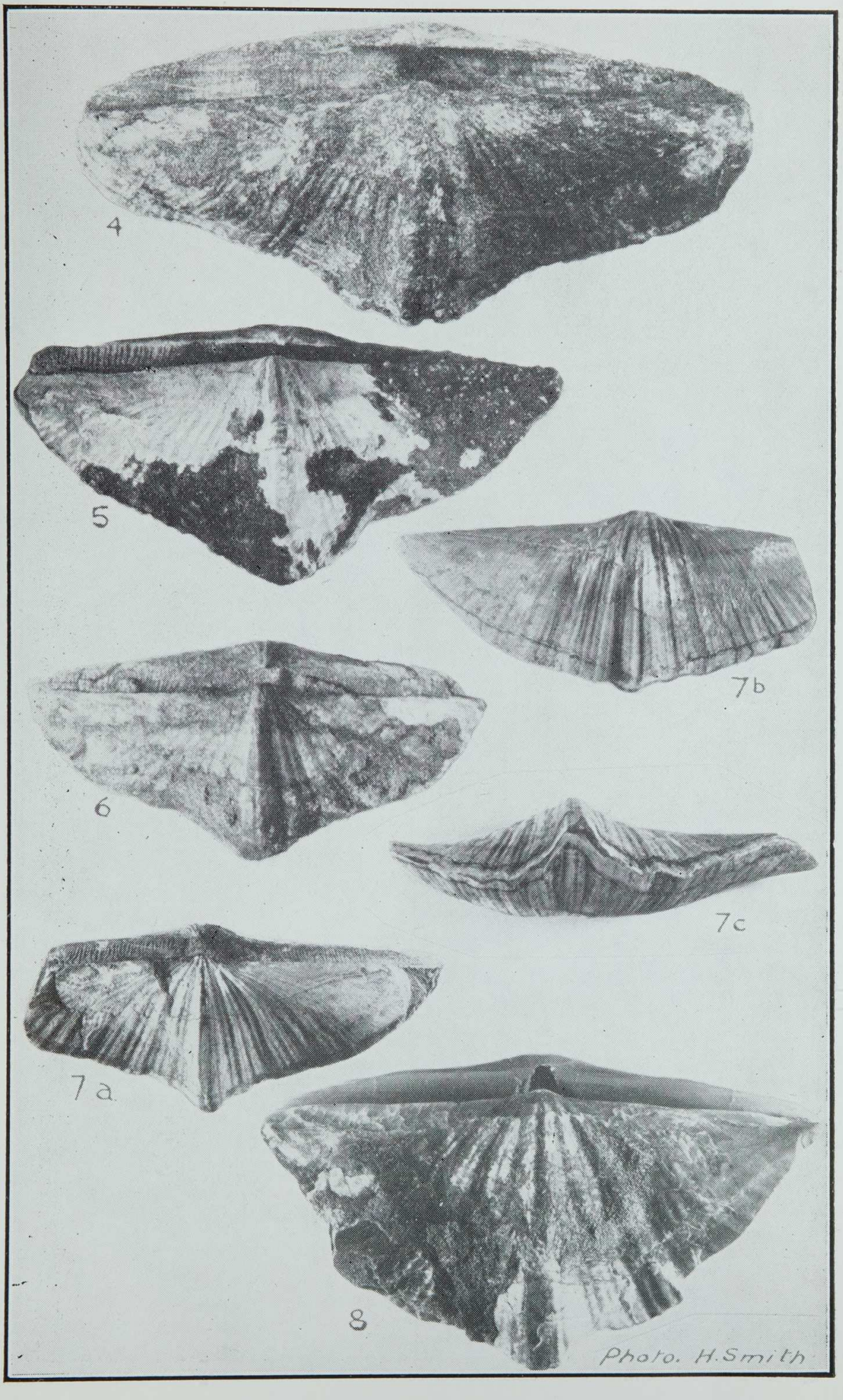


Plate IX.

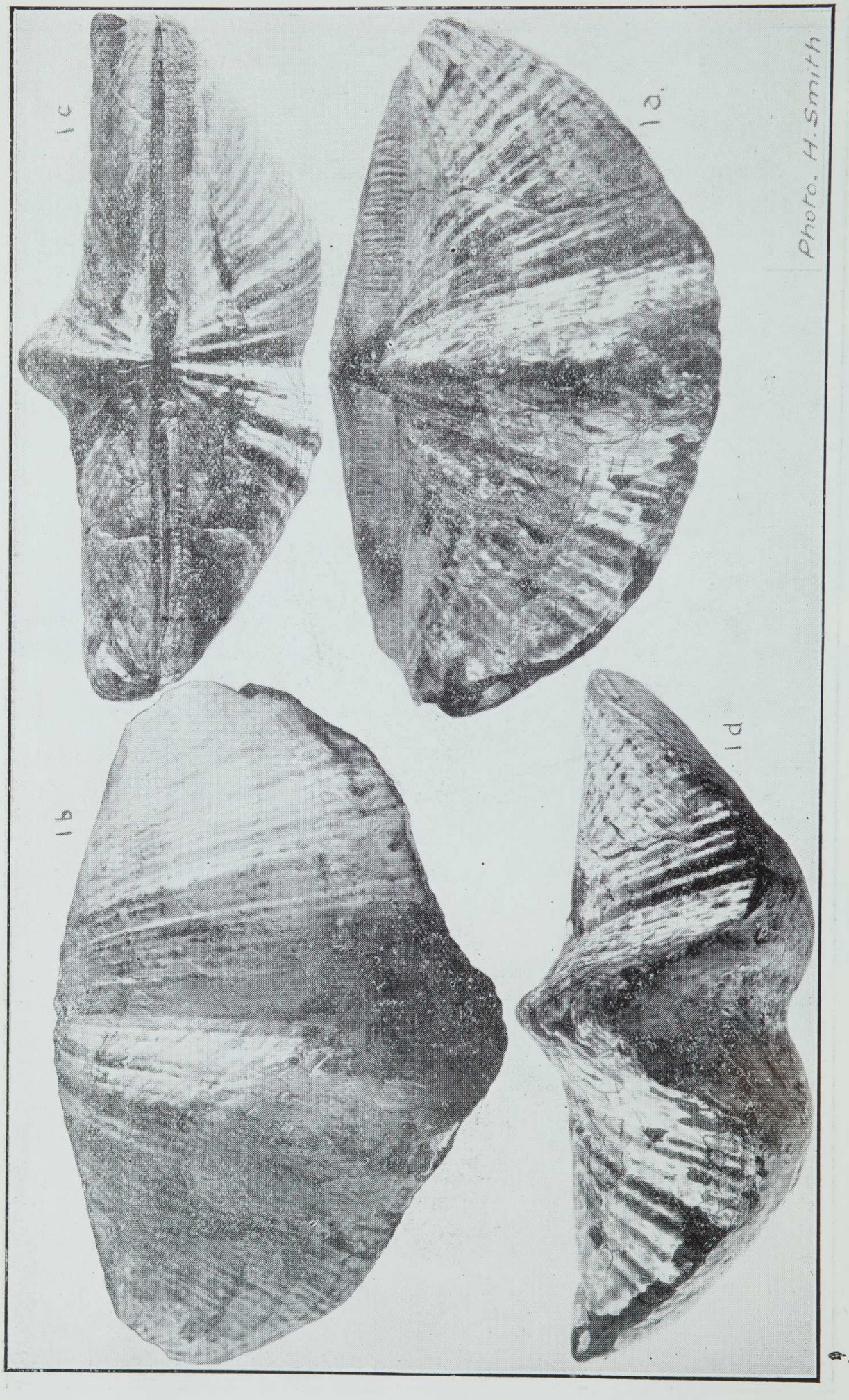


Plate X.

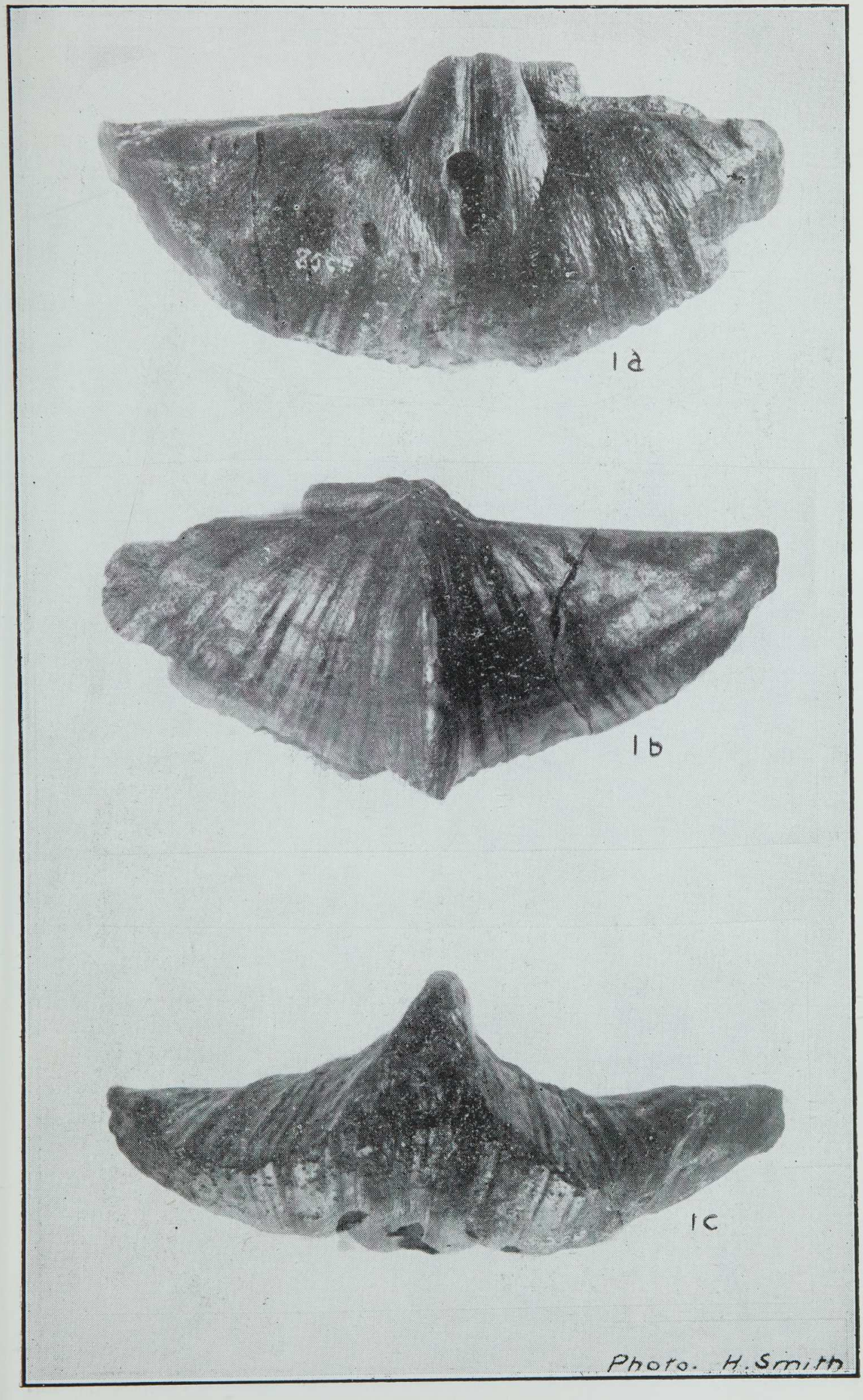
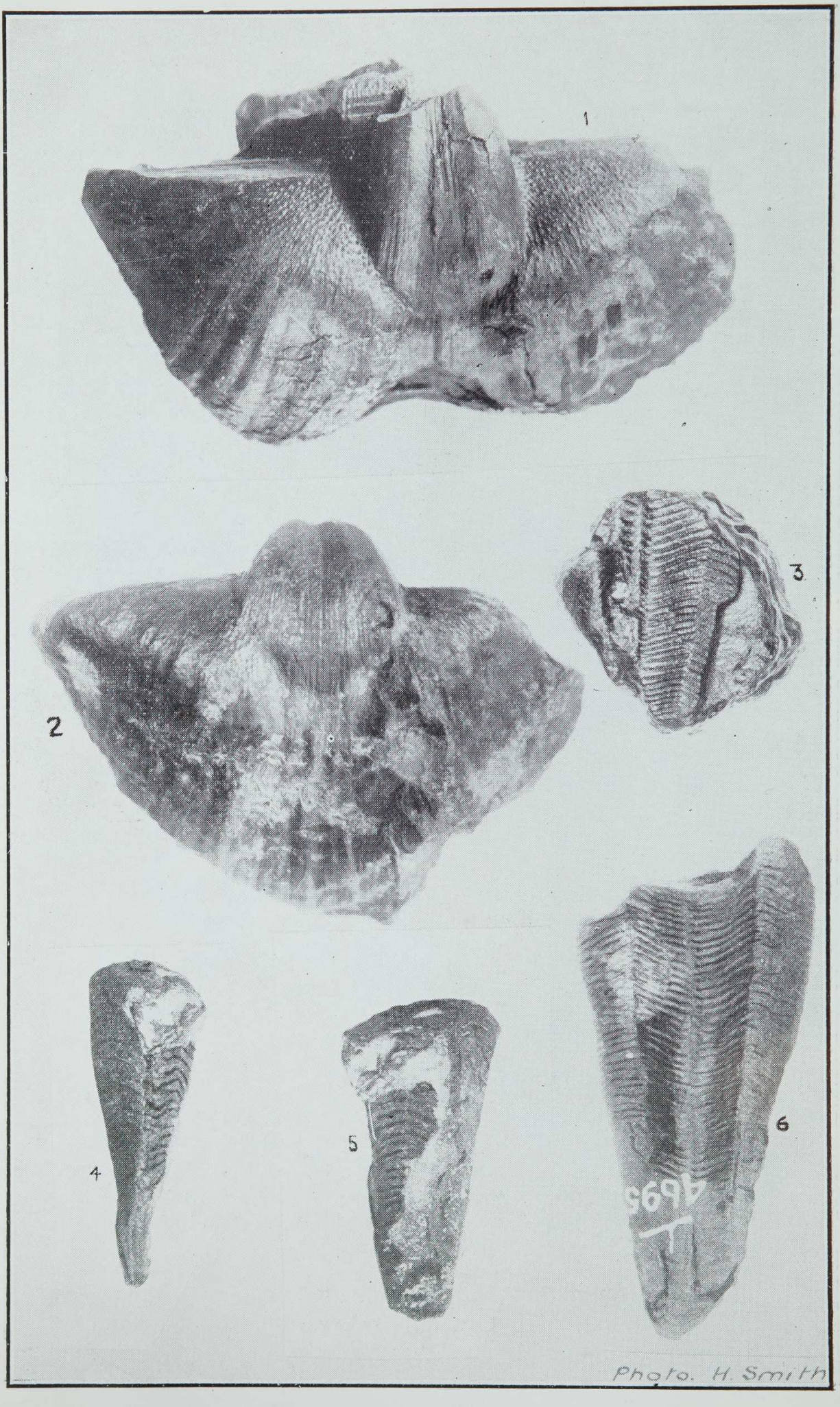


Plate XI.



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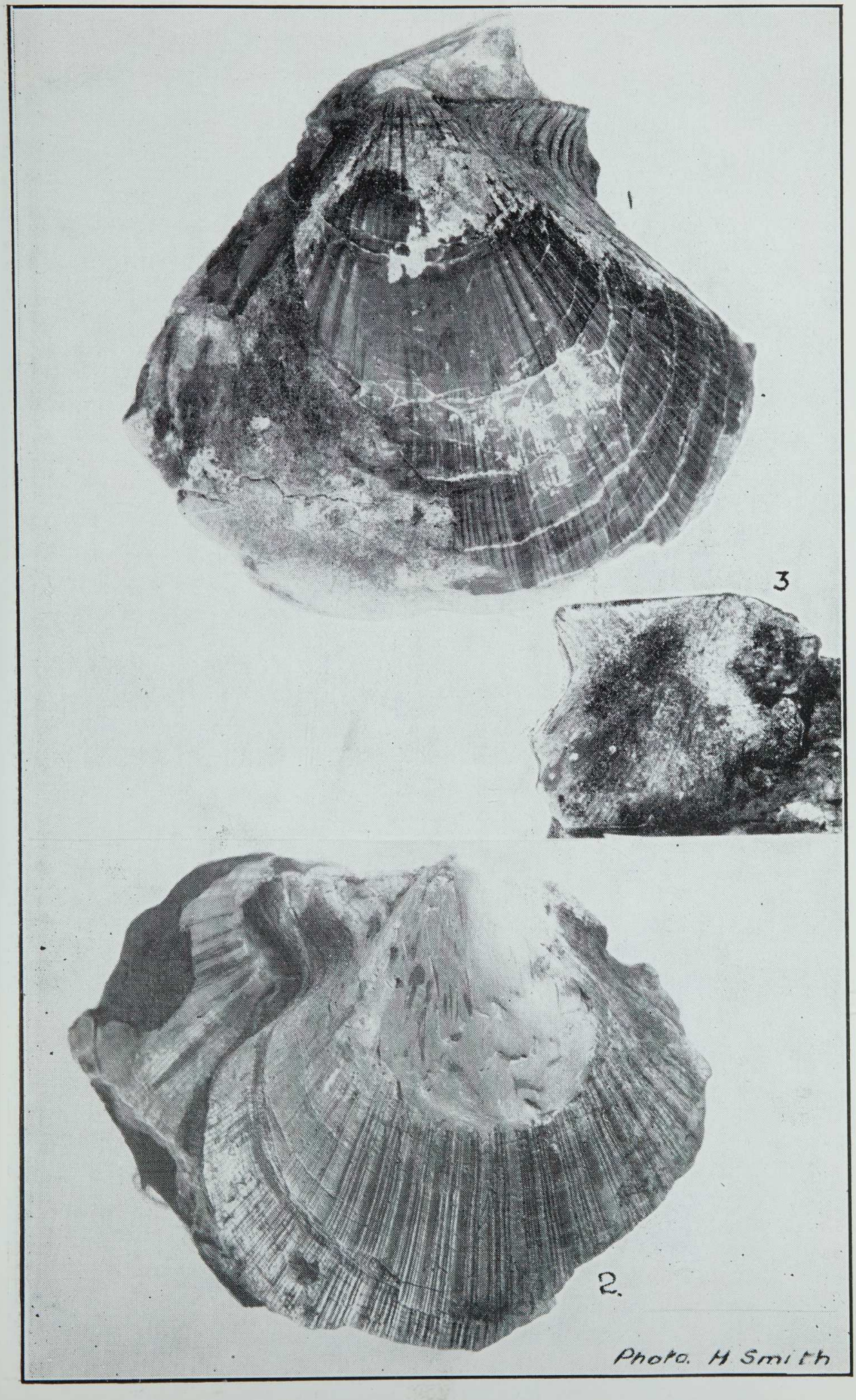
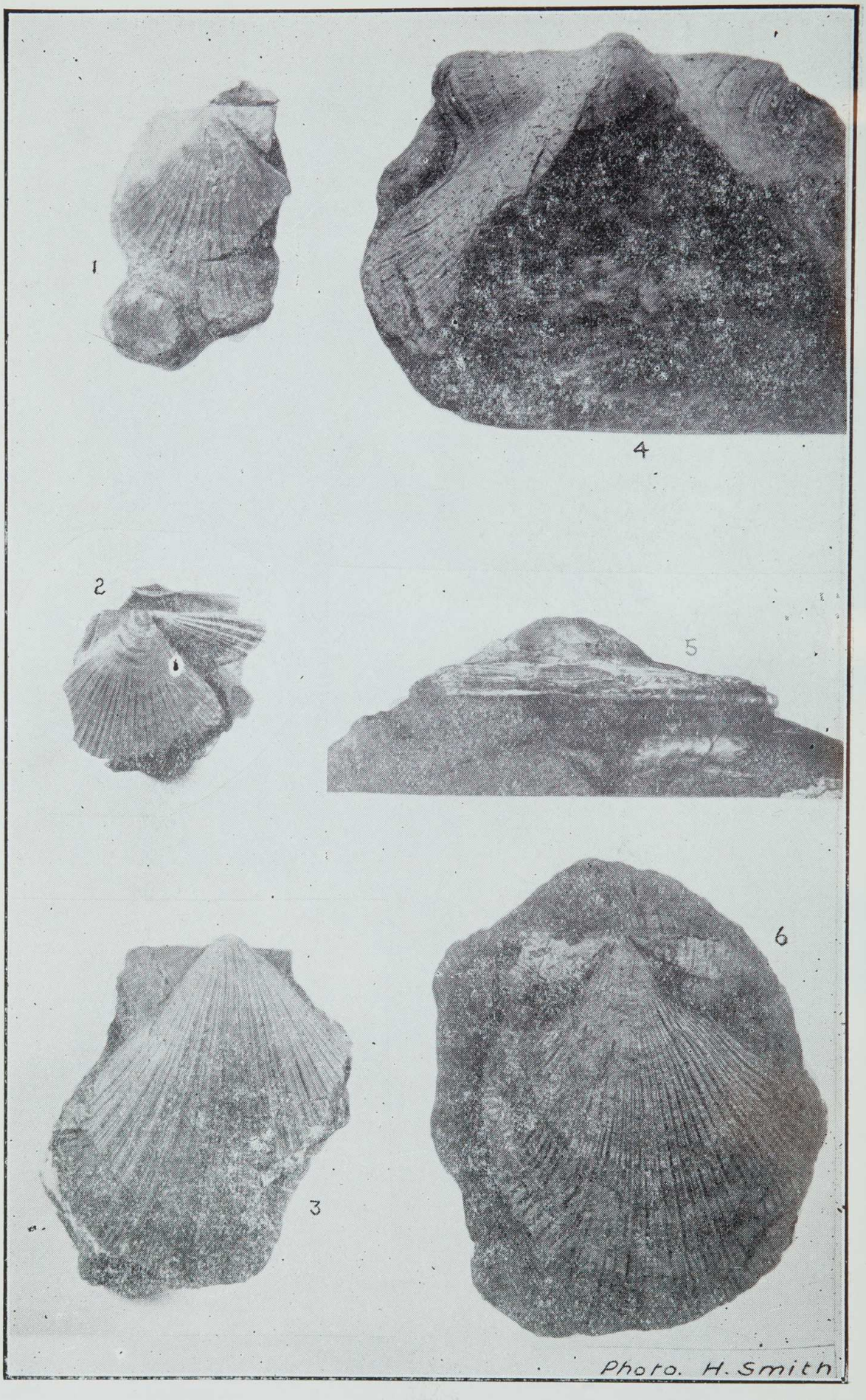


Plate XIII.



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